Chapter 8
Water Quality

8.1 Environmental Setting/Affected Environment

This section defines the environmental setting/affected environment for surface water quality, reviews the environmental and regulatory setting with respect to water quality, and provides an assessment of existing water quality conditions within the project area. Water quality conditions refer to the chemical and physical properties of the surface water in the project area.

Water quality within the Sacramento–San Joaquin Delta (Delta) at any given time and location is a function of the composition of the source water at that location. Source waters may include the Sacramento River, San Joaquin River, eastside tributaries (e.g., Mokelumne, Cosumnes, and Calaveras Rivers), San Francisco Bay, in-Delta runoff, and agricultural return flows Surface water quality can change for many reasons including natural effects of seasonal weather and hydrologic conditions, natural interaction with the terrestrial environment (e.g., soils, vegetation), and from anthropogenic (i.e., human-caused) effects, or direct inputs of contaminants, related to storing, conveying, using, and disposing of water in association with domestic, industrial, and agricultural uses. Natural and anthropogenic contaminants, or *constituents of concern*, can enter Delta waters from various point and nonpoint sources. Point sources are sources of constituents of concern that enter receiving waters at a discrete point, and include treated water from industrial and municipal facilities. Runoff from storm sewers or irrigation is considered a nonpoint source, in that constituents of concern may enter receiving waters at multiple discrete and diffuse points throughout a watershed (i.e., not tracable to a single point). Daily tidal action has a major water quality influence from the high salinity of the Pacific Ocean and specific salinity constituents (e.g., sodium, potassium, chloride, and sulfate) that get transported inland to the Delta through the San Francisco Bay.

Temperature, pH, dissolved oxygen (DO), nutrients and concentrations of other various constituents such as methylmercury and total organic carbon (TOC) can be affected by tidal marsh and floodplain habitats, especially when marsh waters are exchanged with other Delta waters both upstream and downstream of the tidal marsh/floodplain habitats.

8.1.1 Affected Environment

For the purposes of characterizing the existing water quality conditions and evaluating the consequences of implementing the BDCP alternatives on surface water quality, the affected environment is defined as the statutory Delta, and areas to the north and south of the Delta, which are defined in various parts of this chapter as Upstream of the Delta and the SWP/CVP Export Service Areas, as shown in Figure 1-3. When compared to the watershed boundaries, it is noted that the affected environment falls primarily within the Sacramento and San Joaquin River watersheds.

This section identifies the watershed factors that affect water quality, the water quality standards applicable to the affected environment, and the known impairments (i.e., Clean Water Act [CWA]) Section 303[d], the primary constituents of concern in these areas, the regulatory framework, and the key water quality monitoring stations). Finally, water quality data from selected monitoring stations were reviewed for specific constituents.

Because of the very distinct hydrologic and hydraulic characteristics (including the various inflow/outflow conditions) and specific operational details, the water quality in the Delta is described separately from the northern and southern parts of the project area. The Delta environment is much more complex and dynamic compared to the rest of the project area and requires a more detailed approach. Hence, the water quality conditions in the Delta were reviewed at a greater level of detail.

To characterize the existing water quality conditions in the Delta, it is important to evaluate the water quality of the primary inflows to and outflows from the Delta. Consequently, the water quality data compiled and described in this section include monitoring data from the three major rivers in the north (i.e., the Sacramento, Feather, and American Rivers), the tributaries from the east (i.e., the Cosumnes, Mokelumne, and Calaveras Rivers), the San Joaquin River from the south (including its major tributaries), San Francisco Bay water from the west, and agricultural runoff inthe Delta. It also is important to characterize water quality at points where water is pumped out of the Delta (e.g., Harvey O. Banks Pumping Plant [Banks pumping plant], C. W. "Bill" Jones Pumping Plant (Jones pumping plant), Contra Costa Water District [CCWD] Pumping Plant #01, North Bay Aqueduct Pumping Plant), and in areas south of the Delta where exported water is conveyed and stored. Examples of the latter include the Delta-Mendota Canal, the California Aqueduct, and San Luis Reservoir. Similarly, net outflow from the Delta occurs into Suisun Bay at Mallard Island, which is on the western boundary of the Delta and is the approximate boundary between limnetic (salinity of 0–0.5 parts per thousand [ppt]) and oligohaline (salinity of 0.5–5 ppt) areas during median flow conditions (Jassby 2008:4).

8.1.1.1 Organization of the Section

The following sections (Sections 8.1.1.2 through 8.1.3.17) describe the existing conditions in the project area with respect to surface water quality, and are organized in the following sequence.

- **Overview of the Sacramento and San Joaquin River Watersheds** – Brief overview of the watersheds and the Delta environment; location, physical description, and characteristics of the watersheds; climate; and hydrology.
- **Water Management and the State Water Project (SWP) and Central Valley Project (CVP) Systems** – Brief overview of the SWP and CVP, their key features, and the complex hydrodynamics of the project area.
- **Primary Factors affecting Water Quality** – Brief discussion and listing of point and nonpoint pollutant sources, including historic and recent drainage from inactive and abandoned mines, industrial and municipal wastewater treatment plant discharges, agricultural and urban stormwater runoff, recreational uses, and wildlife.
- **Beneficial Uses** – Brief overview of the designated beneficial uses in the project area, as defined in the Regional Water Quality Control Boards' (Regional Water Board) water quality control plans (WQCP or Basin Plan).
- **Water Quality Objectives and Criteria** – Brief discussion of regulatory water quality standards as described in the California Toxics Rule (CTR), water quality control plans, and California drinking water standards.

- **Water Quality Impairments** – Description of Section 303(d) list of impaired water bodies in the project area, existing Total Maximum Daily Loads (TMDLs), and descriptions of major ongoing water quality monitoring programs.
- **Water Quality Constituents of Concern** – Rationale for selecting specific water quality constituents of concern that are important to maintaining the water quality in the project area, and discussion of sensitive receptors affected by water quality.
- **Selection of Monitoring Stations for Characterization of Water Quality** – Brief description of the data sources, selection of monitoring stations to be analyzed, and data availability at the selected locations.
- **Regulatory Setting** – Brief description of federal, state, and regional/local regulatory agencies and the applicable guidance related to surface water quality.

Section 8.1.2, *Selection of Monitoring Stations for Characterization of Water Quality*, includes detailed discussions of the selected water quality constituents of concern in the project area. For each constituent, the discussion is organized by: (1) background information available in the recent literature; (2) importance of the constituent in the project area, including its potential effects on other resources; (3) existing conditions, including concentrations at various monitoring locations; and (4) spatial and temporal trends.

8.1.1.2 Overview of the Sacramento and San Joaquin River Watersheds

Geographic Location and Physical Description

The Delta watershed includes the watersheds of the Sacramento and San Joaquin Rivers, the two largest rivers in the state. Together, the watersheds make up roughly one-third of the state's land area. These rivers originate in the Coast Range, Cascade Range, and Sierra Nevada, and flow through the Central Valley before entering the Delta. The following provides a brief overview of watershed characteristics of the project area; for additional detailed discussion, refer to Chapter 5, *Water Supply*, and Chapter 6, *Surface Water*.

The Delta is a complex system of stream channels, sloughs, marshes, canals, and islands in northern-central California at the confluence of the Sacramento and San Joaquin Rivers. The Delta covers 738,000 acres, which includes 59 islands, 1,100 linear miles of levees, hundreds of thousands of acres of farmland, and various habitat types (California Department of Water Resources 1993:91). The Delta lands and waterways support communities, agriculture, and recreation while providing essential habitat for a multitude of fish and wildlife species.

Delta inflow consists of runoff from the Sacramento River watershed, the San Joaquin River watershed, and the eastside tributaries (i.e., Cosumnes, Mokelumne, and Calaveras Rivers). Long-term average annual Delta inflow is approximately 22 million acre-feet (MAF), with a range of less than 8 MAF to more than 74 MAF (CALFED Bay-Delta Program 2000). Dry and critical year Delta inflow averages about 12 MAF annually under existing conditions (CALFED Bay-Delta Program 2000). As a contributor to the state's agricultural irrigation system and the primary source of drinking water for two-thirds of California's population, the Delta is a critical component of the state's water supply infrastructure.

Area Climate, Hydrology, and Watershed Characteristics

Sacramento River Watershed

The Sacramento River watershed drains the northern part ofCalifornia 's Central Valley. The Sacramento River, California's longest river, is approximately 447 miles long and drains approximately 27,000 square miles of land. Predominant land uses in the Sacramento River watershed include agriculture, natural (i.e., undeveloped), and urban areas. The major Sacramento River watershed drainages include the upper Sacramento, Feather, Yuba, and American Rivers (Figure 8-1).

The climate in the Sacramento River watershed is Mediterranean in character, typified by cool, wet winters and warm, dry summers. Daily high air temperatures in the Sacramento Valley range from around 45°F in the winter to over 100°F in the summer. Average air temperatures in the mountainous regions of the watershed are typically 5–10° less than the temperature on the valley floor. Annual precipitation in the Sacramento River watershed ranges from 80 to 90 inches of primarily snowfall in the mountainous regions, to 41 inches of rain in Redding and 19 inches in Sacramento. Average annual precipitation for the entire watershed is approximately 36 inches. Most precipitation falls between November and April, with little or no precipitation falling between May and October (CALFED Bay-Delta Program 2000).

The majority of the runoff in the Sacramento River watershed is in theupper Sacramento River watershed and in the rivers flowing out of the western slope of the Sierra Nevada. Numerous reservoirs are located in the Sacramento River watershed The major reservoirs in the Sacramento River Watershed include Shasta Lake, Lake Oroville, and Folsom Lake. Trinity Lake lies within the coastal watershed, and water is diverted from it to the Sacramento River watershed. Total reservoir capacity in the Sacramento River watershed, including Trinity Lake, is approximately 16 MAF (California Department of Water Resources 2005a).

An important characteristic of the Sacramento River watershed is that precipitation patterns are highly variable from year to year and within years. Figure 8-2 illustrates the precipitation pattern in the Sacramento Valley for water years between 1977 and 2008. Surface water supply is measured by "water year". A "water year" is defined as the 12-month period of October 1 through September 30 of the following year. The water year is designated by the calendar year in which it ends (e.g., the year ending September 30, 2010 is called the "2010" water year). The Sacramento River Index is a "yardstick" of northern California water supply or water availability from the Sacramento River watershed. The index is is used to project the current water year type and is based partially on the previous year's index and on the sum of the unimpaired runoff (in MAF) of four rivers: Sacramento River above Bend Bridge near Red Bluff, Feather River inflow to LakeOroville, Yuba River at Smartville, and American River inflow to Folsom Lake. Unimpaired runoff is an estimate of the runoff that would occur in a watershed if unaltered by upstream diversions, storage, or export/import of water to/from other watersheds. Based on the unimpaired runoff, the water year type classifications are defined as follows.

- Wet: Equal to or greater than 9.2 MAF.
- Above Normal: Greater than 7.8 and less than 9.2 MAF.
- Below Normal: Greater than 6.5 and equal to or less than 7.8 MAF.
- Dry: Greater than 5.4 and equal to or less than 6.5 MAF.

- Critical: Equal to or less than 5.4 MAF.

Relative water availability from the watershed is greatest in wet years and lowest in critical years. In the past 32 years, 10 years were wet (31%), 6 years were above normal (19%), 2 years were below normal (6%), 7 years were dry (22%), and 7 years were critical (22%).

San Joaquin River Watershed

The San Joaquin River watershed drains the southern part of the Central Valley. The San Joaquin River, California's second longest river, is approximately 330 miles long and drains approximately 32,000 square miles of land. Similar to the Sacramento River watershed, predominant land uses in the San Joaquin River watershed consist of agriculture, natural(i.e., undeveloped), and urban areas. The main San Joaquin River watershed drainages include the upper San Joaquin, Merced, Tuolumne, and Stanislaus Rivers (Figure 8-3).

The climate in the San Joaquin River watershed is similar to the Sacramento River watershed, but is generally warmer and drier. Air temperatures in the City of Fresno range from 37°F in the winter to over 100°F in the summer. Annual precipitation in the San Joaquin Valley ranges from 8 to 12 inches of rain.

The warmer and drier conditions in the San Joaquin River watershed result in considerably less runoff compared to the Sacramento River watershed. Compared to the Sacramento River watershed, the San Joaquin watershed runoff also depends more on the annual snowfall compared to rainfall. The annual unimpaired runoff of the San Joaquin River watershed is approximately 5.5 MAF, with 60% of runoff occurring on the Merced, Tuolumne, and Stanislaus Rivers. Of the 5.5 MAF total unimpaired runoff, approximately 3 MAF flows into the Delta, past Vernalis (CALFED Bay-Delta Program 2000). Major reservoirs and impoundments in the San Joaquin River watershed include New Melones Lake, Hetch Hetchy, New Don Pedro Lake, Lake McClure, and Millerton Lake. Total reservoir capacity in the San Joaquin River watershed is approximately 11 MAF (California Department of Water Resources 2005a). Figure 8-4 illustrates the highly variable precipitation pattern within the San Joaquin Valley for water years between 1977 and 2008. The water year type classification used in Figure 8-4 is determined based partially on the previous year's index and on the sum of unimpaired flow (in MAF) at Stanislaus River below Goodwin Reservoir (inflow to New Melones Lake), Tuolumne River below La Grange (inflow to New Don Pedro Lake), Merced River below Merced Falls (inflow to Lake McClure), and San Joaquin River inflow to Millerton Lake. The water year type classifications are defined as follows.

- Wet: Equal to or greater than 3.8 MAF.
- Above Normal: Greater than 3.1 and less than 3.8 MAF.
- Below Normal: Greater than 2.5 and equal to or less than 3.1 MAF.
- Dry: Greater than 2.1 and equal to or less than 2.5 MAF.
- Critical: Equal to or less than 2.1 MAF.

In the past 32 years, 12 years were wet (37%), 4 years were above normal (13%), 1 year was below normal (3%), 5 years were dry (16%), and 10 years were critical (31%).

8.1.1.3 Water Management and the State Water Project and Central Valley Project Systems

The management of the SWP and CVP systems to meet water supply, flood management, and environmental obligations has a substantial effect on the quantity and timing of inflows to the Delta and on water quality in the project area. This section provides a brief overview of the SWP and CVP facilities and their operations. The following provides a brief overview of surface water management in the project area; for additional detailed discussion, refer to Chapter 5, *Water Supply*, andChapter 6, *Surface Water*.and. Figure 8-5 provides an overview of key facilities in the SWP and CVP systems.

State Water Project

The SWP's 33 water storage facilities, 600 miles of aqueducts, and multiple pumping plants and hydroelectric plants supply water to approximately 23 million Californians and to approximately 700,000 acres of farmland. Depending on the water year type (i.e., available water supply) and demands, the SWP annually delivers up to about 3.7 MAF to meet contract demands. However, in drier water year types when supply is limited, deliveries are considerably lower with an estimated 50% delivery reliability in any given water year of less than 2.7 MAF (California Department of Water Resources 2010a). The primary objectives of the SWP arethe following.

- Supply water to urban areas in Southern California, south San Francisco Bay, the central California coast, and South Bay contractors, and South Bay contractors.
- Manage floodwaters in the Sacramento Valley.
- Supply farmers with irrigation water (primarily in the Central Valley).

Distribution of SWP water begins with releases from Oroville Dam into the Feather River, which flows into the Sacramento River at River Mile 80 and, ultimately, to the Delta. SWP pumps water into the North Bay Aqueduct from Barker Slough in the north Delta for use in Napa and Solano Counties. In the south Delta, water also is pumped into the South Bay Aqueduct to serve areas of Alameda County and Santa Clara County, and via the Banks pumping plant into the 444-mile-long California Aqueduct (California Department of Water Resources 2009a). The California Aqueduct conveys water south primarily to meet potable water demands of SWP contractors serving Central Valley, and southern California counties, and to meet agricultural demands in the San Joaquin Valley and Tulare Basin. The California Aqueduct delivers water to O'Neil Forebay and the San Luis Reservoir, a storage reservoir jointly owned by the SWP and CVP. Water is delivered to Santa Clara County and San Benito County from San Luis Reservoir via the Santa Clara and Hollister conduits. The Coastal Branch Aqueduct diverts water from the California Aqueduct to areas west in San Luis Obispo and Santa Barbara Counties. In southern California, water is delivered to the major storage reservoirs of Lake Perris, Silverwood Lake, Castaic Lake, and Lake Pyramid.

The California Department of Water Resources (California Department of Water Resources) manages the SWP to supply the 29 contracting public agencies, provide recreation opportunities, generate hydroelectric power, and protect fish and wildlife. These objectives are achieved by increasing or decreasing upstream water releases, changing Delta pumping rates, or storing river flows downstream of the Delta at the San Luis Reservoir (Water Education Foundation 2004). During February through June, DWR reduces the ratio of water exports to inflows to reduce potential impacts on migrating salmon and spawning delta smelt, Sacramento splittail, and striped bass (Sacramento Area Flood Control Agency 2004). SWP facilities are also operated to meet water quality objectives, such as the "X2" location objective. X2 refers to the location in the Delta where the salinity concentration of 2 parts of salt in 1,000 parts of water occurs; the X2 standard was established to improve shallow water estuarine habitat in the months of February through June and relates to the extent of salinity movement into the Delta (Sacramento Area Flood Control Agency 2004). The location of X2 is important to both aquatic life and water supply beneficial uses.

Central Valley Project

The CVP annually delivers approximately 7 MAF of water for agricultural, urban, and wildlife use and is the largest water storage and delivery system in California (Bureau of Reclamation 2009a; CALFED Bay-Delta Program 2000). The CVP system consists of 20 dams and reservoirs, 11 hydropower plants, 500 miles of major canals, and additional related facilities (Bureau of Reclamation 2009a).

Transfer of water through the CVP system and the Delta begins with the release of water from reservoirs located on the Trinity, Sacramento, American, and Stanislaus Rivers(Bureau of Reclamation 2009a) (Figure 8-5). Water released from Trinity and Shasta Damsflows into Keswick Reservoir and is then released into the Sacramento River from Keswick Dam at River Mile 303. A portion of the river's flow is diverted by the Red Bluff Diversion Dam (River Mile 243) into the Tehama-Colusa and Corning Canals to irrigate the western side of the Sacramento Valley (Water Education Foundation 2002). The remainder of the Trinity and Shasta releases continue flowing south in the Sacramento River, combining with CVP releases from Folsom and Nimbus Dams at the confluence of the Sacramento and American Rivers and, ultimately, flowing to the Delta in the vicinity of Freeport (Figure 8-5). The Stanislaus River releases of water from New Melones Lake serve as a water source for CVP users in the Stanislaus River watershed and in the northern San Joaquin Valley (Bureau of Reclamation 2009a).

In the Delta, the released water is exported from the Delta by the Jones pumping plant into the Delta-Mendota Canal, which conveys water south for agricultural uses in the San Joaquin Valley. Water transported in the 117-mile Delta-Mendota Canal can be used as an irrigation supply, a source of San Luis Reservoir water, for managed wetland refuges, or as a replacement for upper San Joaquin River water used in the Friant-Kern and Madera Canal systems (Bureau of Reclamation 2009a). The San Luis Reservoir is an off-stream storage reservoir that is used by both SWP and CVP to provide water to Central Valley and Bay Area users (Bureau of Reclamation 2009b). The Friant-Kern and Madera Canal systems originate at Friant Dam and transport upper San Joaquin River water approximately 152 miles south to Bakersfield and approximately 36 miles to the north, respectively (Water Education Foundation 2002). Additionally, CVP's Contra Costa Canal conveys Delta water from Rock Slough. CCWD's Los Vaqueros Pipeline diverts water from Old River to the west to meet potable demands of Bay Area users served by CCWD (Bureau of Reclamation 2009a).

The Bureau of Reclamation (Reclamation) operates the CVP to meet the following objectives (Bureau of Reclamation 2009a).

- Regulate rivers and improve flood management and navigation.
- Provide water for irrigation and domestic use.
- Generate power.
- Provide for recreation opportunities.
- Protect fish and wildlife.

- Improve water quality.

Reclamation's operation of the CVP facilities changes seasonally based on varying management objectives. During the winter and early spring months when flood management is a priority, CVP reservoirs are operated to store winter runoff (Water Education Foundation 2002). Releases during May through October are timed to meet a variety of water supply needs, manage water quality, and create available storage capacity for flood flows (Water Education Foundation 2002).

Hydrodynamics in the Delta

Delta hydrodynamics are a product of a complex interaction of tributary inflows, tides, in-Delta diversions, and SWP and CVP operations, including conveyance, pumping plants, and operations of channel barriers and gates designed to direct tributary inflows to certain regions of the Delta. Each region is affected differently by these variables, and the nature of the effect varies daily, seasonally, and from year to year, depending on the magnitude of inflows, the tidal cycle, and the extent of pumping at the SWP and CVP pumping plants.

For example, the SWP and CVP pumping plants can affect the flow of water in the Delta channels, particularly during periods of low water flow and high export quantities. Normal flows in the Delta travel to the west, toward Suisun and San Francisco Bays. However, SWP and CVP pumping can reverse the Delta flows and cause the water to move to the east and south, which causes more saline water to move farther inland (Bureau of Reclamation 2009a).

The Delta Cross Channel is a controlled diversion channel that transports Sacramento River water to Snodgrass Slough and then to the Mokelumne River, where it flows into the central and south Delta (Chapter 6, *Surface Water*, Figure 6-9). Opening the Delta Cross Channel's gates can generally reduce salinity in some channels of the central and southern Delta, particularly during the summer months, through the transport of relatively low salinity Sacramento River water into the Delta to dilute and combat saltwater intrusion (Bureau of Reclamation 2009a).

Flow in the Delta channels can change direction as a result of tidal exchange, ebbing and flooding with the two tides per day, which is a major factor of Delta hydrodynamics. The daily, seasonal, and year-to-year differences in source water contributions to various locations throughout the Delta affect the water quality in the Delta, particularly with regard to salinity. Figure 8-6 and Figure 8-7 show the variations in maximum intrusion of chloride into the Delta since 1921, which demonstrate that variability and intrusion distance has generally been reduced following construction of the major storage reservoirs and implementation of Delta water management facilities and operations. However, it also has been demonstrated that on a seasonal and water year basis,the location of elevated salinity conditions in the central Delta, on average, intrude from 3 to 15 miles farther inland since development began in the Delta 150 years ago (Contra Costa Water District 2010). The higher average salinity conditions are generally attributable to increased diversion of water from the Delta since the 1940s (Contra Costa Water District 2010).

8.1.1.4 Primary Factors Affecting Water Quality

Primary factors affecting water quality in the project area include patterns of land use in the upstream watersheds and the Delta, SWP and CVP operations, and in-Delta activities and sources of pollutants. Point and nonpoint pollutant sources include historic and recent drainage from inactive and abandoned mines and related debris/sedminent, industrial and municipal wastewater treatment plant discharges, agricultural drainage, urban stormwater runoff, atmospheric deposition, recreational uses, and metabolic waste (e.g., pathogens) from wildlife. Figure 8-8 shows land uses and major point sources (i.e., consisting primarily of municipal wastewater treatment plants) and nonpoint sources (e.g., urban stormwater runoff) of pollutants. Natural erosion and instream sediments, atmospheric deposition, and geothermal inputs (CALFED Bay-Delta Program 2000) also affect Delta water quality. The magnitude of the effect of each of these sources is correlated with the relative contribution from each source, and can differ for different constituents. The principal contaminants and conditions affecting water quality in the Delta are as follows (CALFED Bay-Delta Program 2000).

- Historical drainage and sediment discharged from upstream mining operations in the late 1800s and early 1900s has contributed metals, such as cadmium, copper, and mercury.
- Stormwater runoff can contribute metals, sediment, pathogens, organic carbon, nutrients, pesticides, dissolved solids (salts), petroleum products, and other chemical residues.
- Wastewater discharges from treatment plants can contribute salts, metals, trace organics, nutrients, pathogens, pesticides, organic carbon, personal care products, pharmaceuticals, and oil and grease.
- Agricultural irrigation return flows and nonpoint discharges can contribute salts (including bromide), organic carbon, nutrients, pesticides, pathogens, and sediment.
- Large dairies and feedlots can contribute nutrients, organic carbon, and pathogenic organisms.
- Water-based recreational activities (such as boating) can contribute hydrocarbon compounds, nutrients, and pathogens.
- Atmospheric deposition can contribute metals, nutrients, pesticides, and other synthetic organic chemicals, and may lower pH.
- Seawater intrusion can contribute salts, including bromide, which affect total dissolved solids (TDS) concentrations and can contribute to formation of unwanted chemical byproducts in treated drinking water. Additionally, seawater can contribute sulfate, which can influence the methylation of mercury.
- Miscellaneous contaminants and conditions from the San Joaquin River include selenium and low dissolved oxygen (DO).

Both variations in watershed hydrology and SWP and CVP operations affect the variability of water quality in the project area, as well as water diversions which reduce the amount of water available for dilution and assimilation of contaminant inputs and hydrodynamic conditions associated with channel flows and tidal action in the Delta. Water quality can vary seasonally in response to winter-spring runoff and summer-fall lower flow periods, and can also vary from year to year as a result of precipitation and snow pack levels in the upper watersheds, and the resulting releases from upstream reservoirs for water supply, flood management, and environmental obligations (e.g., fish flows, Delta water quality objective compliance), operations of the Delta Cross Channel, and seasonal and annual variations in SWP and CVP pumping rates.

8.1.1.5 Beneficial Uses

Water bodies in the project area are used for many purposes as evidenced by the number of beneficial uses shown in Table 8-1. Beneficial uses are designated for specific water bodies, either as existing or potential, by each Regional Water Board in their respective WQCPs or Basin Plans. For water bodies where beneficial uses have not specifically been identified in a Basin Plan, the *tributary rule* allows a Regional Water Board to apply the designated beneficial uses that exist in the nearest downstream tributary. Established in the 1978 WQCP for the San Francisco Bay/Sacramento-San Joaquin Delta Estuary (Bay-Delta WQCP), designated beneficial uses of Delta water remain unchanged in the 1991, 1996, and 2006 WQCPs. Additionally, the individual Basin Plans for the San Francisco Bay Regional Water Quality Control Board (San Francisco Bay Regional Water Board) and Central Valley Regional Water Quality Control Board (Central Valley Water Board) identify beneficial uses of the Delta areas within their jurisdictions.

Table 8-1. Designated Beneficial Uses for Water Bodies in the Project Area

Name[a]	Abbreviation[a]	Beneficial Uses[a]
Designated Beneficial Uses Common to Inland Waters in All Basin Plans and the Delta		
Municipal and Domestic Supply	MUN	Uses of water for community, military, or individual water supply systems including drinking water supply
Agricultural Supply	AGR	Uses of water for farming, horticulture, or ranching including irrigation (including leaching of salts), stock watering, or support of vegetation for range grazing
Industrial Service Supply	IND	Uses of water for industrial activities that do not depend primarily on water quality including mining, cooling water supply, hydraulic conveyance, gravel washing, fire protection, or oil well repressurization
Industrial Process Supply	PRO	Uses of water for industrial activities that depend primarily on water quality
Groundwater Recharge	GWR	Uses of water for natural or artificial recharge of groundwater for purposes of future extraction, maintenance of water quality, or halting of saltwater intrusion into freshwater aquifers
Navigation	NAV	Uses of water for shipping, travel, or other transportation by private, military, or commercial vessels
Water Contact Recreation	REC-1	Uses of water for recreational activities involving body contact with water where ingestion of water is reasonably possible, including swimming, wading, water-skiing, skin and scuba diving, surfing, white-water activities, fishing, or use of natural hot springs
Non-Contact Water Recreation	REC-2	Uses of water for recreational activities involving proximity to water but where there is generally no body contact with water nor any likelihood of ingestion of water, including picnicking, sunbathing, hiking, beachcombing, camping, boating, tide pool and marine life study, hunting, sightseeing, or aesthetic enjoyment in conjunction with the above activities
Commercial and Sport Fishing	COMM	Uses of water for commercial or recreational collection of fish, shellfish, or other organisms, including uses involving organisms intended for human consumption or bait purposes
Warm Freshwater Habitat	WARM	Uses of water that support warm water ecosystems, including preservation or enhancement of aquatic habitats, vegetation, fish, or wildlife, including invertebrates
Cold Freshwater Habitat	COLD	Uses of water that support cold water ecosystems, including preservation or enhancement of aquatic habitats, vegetation, fish, or wildlife, including invertebrates
Wildlife Habitat	WILD	Uses of water that support terrestrial or wetland ecosystems, including preservation and enhancement of terrestrial habitats or wetlands, vegetation, wildlife (e.g., mammals, birds, reptiles, amphibians, invertebrates), or wildlife water and food sources

Name[a]	Abbreviation[a]	Beneficial Uses[a]
Preservation of Biological Habitats of Special Significance	BIOL	Uses of water that support designated areas or habitats, such as established refuges, parks, sanctuaries, ecological reserves, or Areas of Special Biological Significance, where the preservation or enhancement of natural resources requires special protection
Rare, Threatened, or Endangered Species	RARE	Uses of water that support aquatic habitats necessary, at least in part, for the survival and successful maintenance of plant or animal species established under state or federal law as rare, threatened, or endangered
Migration of Aquatic Organisms	MIGR	Uses of water that support habitats necessary for migration or other temporary activities by aquatic organisms, such as anadromous fish
Spawning, Reproduction, and/or Early Development	SPWN	Uses of water that support high quality aquatic habitats suitable for reproduction and early development of fish
Shellfish Harvesting	SHELL	Uses of water that support habitats suitable for the collection of filter feeding shellfish (e.g., clams, oysters, and mussels) for human consumption, commercial, or sports purposes
Additional Beneficial Uses of the Delta		
Estuarine Habitat	EST	Uses of water that support estuarine ecosystems, including preservation or enhancement of estuarine habitats, vegetation, fish, shellfish, or wildlife (e.g., estuarine mammals, waterfowl, shorebirds)
Additional Beneficial Uses of Inland Waters (not common to all Basin Plans)		
Freshwater Replenishment[b]	FRSH	Uses of water for natural or artificial maintenance of surface water quantity or quality
Hydropower Generation[c]	POW	Uses of water for hydropower generation
Aquaculture[c]	AQUA	Uses of water for aquaculture or mariculture operations, including propagation, cultivation, maintenance, or harvesting of aquatic plants and animals for human consumption or bait purposes
Inland Saline Water Habitat[d]	SAL	Uses of water that support inland saline water ecosystems, including preservation or enhancement of aquatic saline habitats, vegetation, fish, or wildlife, including invertebrates
Limited Warm Freshwater Habitat[e]	LWRM	Waters that support warm water ecosystems that are severely limited in diversity and abundance as the result of concrete-lined watercourses and low, shallow dry weather flows, which result in extreme temperature, pH, and/or DO conditions; naturally reproducing finfish populations are not expected to occur in LWRM waters

[a] The names, abbreviations, and beneficial use descriptions are not identical in each Basin Plan.

[b] Potential beneficial use identified in Sacramento–San Joaquin, San Francisco Bay, Central Coast, Los Angeles, and San Diego Basin Plans.

[c] Potential beneficial use identified in Sacramento–San Joaquin, Central Coast, Los Angeles, Santa Ana, and San Diego Basin Plans.

[d] Potential beneficial use identified in Central Coast, Los Angeles, and San Diego Basin Plans.

[e] Potential beneficial use identified in Santa Ana Basin Plan only.

Sources: Central Coast Regional Water Quality Control Board 1994; Central Valley Regional Water Quality Control Board 2009a; Los Angeles Regional Water Quality Control Board 1994; Santa Ana Regional Water Quality Control Board 2008; San Diego Regional Water Quality Control Board 2007; San Francisco Bay Regional Water Quality Control Board 2007; State Water Resources Control Board 2006.

There are several additional beneficial uses in the Central Valley Water Board Basin Plan that are applicable to surface waters other than the Delta in the Sacramento River basin and south of the Delta export service area. Additionally, south of Delta exports are conveyed to service areas of SWP contractors that lie within the jurisdictions of the Central Coast, Los Angeles, Santa Ana, and San Diego Regional Water Boards, which address several other beneficial uses that are unique to those geographic regions.

8.1.1.6 Water Quality Objectives and Criteria

It is important to define the terms *standards, numerical and narrative Basin Plan water quality objectives*, CTR *criteria*, and U.S. Environmental Protection Agency (USEPA) *recommended criteria* as they relate to the assessment of water quality. As defined by USEPA, water quality standards consist of: (1) the designated beneficial uses of a water segment; (2) the water quality criteria (referred to as *objectives* by the state) necessary to support those uses; and (3) an antidegradation policy that protects existing uses and high water quality. Each Regional Water Board's Basin Plan identifies numeric and narrative water quality objectives, together with the beneficial uses assigned to water bodies and the state antidegradation policy. By definition, Basin Plan objectives have gone through the standards setting process, which includes public participation, consideration of economics, environmental review, and state and federal agency review and approval. Consequently, Basin Plan objectives are legally applicable and enforceable. The CTR criteria were established through the USEPA-led water quality standards setting process. Hence, the CTR criteria, together with the beneficial uses assigned to water bodies and the state antidegradation policy, constitute additional water quality standards for the regions (beyond those specified in the Basin Plans). Finally, USEPA periodically recommends ambient water quality criteria to states for their consideration in adopting state standards. As stated by USEPA, the USEPA recommended criteria (also referred to as 304[a][1] criteria) "…are not regulations, and do not impose legally binding requirements on EPA, States, tribes or the public." Therefore, USEPA recommended criteria and other nonenforceable guidance values are referred to as *advisory* when discussed in this chapter in order to distinguish them from adopted objectives and criteria.

Applicable ambient surface water quality criteria and objectives for the project area are contained in the following sources.

- CTR (criteria applicable to all surface waters in California).
- *2006 Water Quality Control Plan for the San Francisco Bay/Sacramento-San Joaquin Delta Estuary* (Bay-Delta WQCP or the 1995 WQCP) (objectives applicable to the Delta only, regulated through water rights conditions by the State Water Resources Control Board [State Water Board]).
- Central Valley Water Board and San Francisco Bay Regional Water Board Basin Plans (objectives applicable to the Delta and other surface waters in the project area, regulated through point and nonpoint source controls).
- Basin Plans for the Central Coast, Los Angeles, Santa Ana, and San Diego Regional Water Boards (applicable to surface waters in the south of Delta areas served by SWP exports).

Along with the concentration value, numerical water quality objectives also typically specify an averaging period to which the concentration value applies to protect the beneficial use of interest. Averaging periods typically depend on the sensitivity of the use, such as a 1-hour averaging period for objectives designed to prevent acute toxicity in aquatic life, to longer averaging periods (e.g., 30-day, annual average) for less sensitive effects (e.g., human health effects, industrial uses, or agricultural crop production). In the Delta, the value of some numerical water quality objectives (i.e., primarily for aquatic life) depend on the prevailing ambient freshwater and saltwater salinity conditions. The salinity conditions across the large majority of the Delta are sufficiently low such that the Delta channels are subject to freshwater regulatory water quality criteria/objectives. However, tidal influence and associated saltwater intrusion can result in salinity concentrations in areas of the west Delta that require regulation with saltwater criteria/objectives. Appendix 8A, *Water Quality Criteria and Objectives*, summarizes the specific water quality criteria/objectives that are applicable to the Delta. State objectives can be numeric or narrative. A numeric objective defines a concentration that shall not be exceeded for a parameter (e.g., 10 milligrams per liter [mg/L]). A narrative objective establishes a *desired level of protection* or describes a *favorable condition to be achieved* rather than defining a specific numerical concentration. An example of a narrative objective is: "Waters shall not contain chemical constituents in concentrations that adversely affect beneficial uses."

California Toxics Rule

CTR criteria are established only for the aquatic life and human health protection. CTR criteria for aquatic life protection for some constituents (i.e., most metals, cyanide, various organic compounds) are specified for freshwater and saltwater conditions. The CTR states that the salinity characteristics (i.e., freshwater versus saltwater) of the receiving water shall be considered in determining the applicable criteria. Freshwater criteria shall apply to waters with salinity equal to or less than 1 ppt at least 95% of the time. Saltwater criteria apply to waters with salinity equal to or greater than 10 ppt at least 95% of the time in a normal water year. For waters with salinity between these two categories, or tidally influenced freshwaters that support estuarine beneficial uses, the applicable criteria are the lower of the freshwater or saltwater values for each substance. CTR criteria for the protection of human health are specified that apply to any receiving water where human consumption of water and/or organisms occurs. Refer to Section 8.2, *Regulatory Setting*, for additional detail about the CTR and other applicable water quality regulations. Appendix 8A provides the applicable CTR criteria specified for aquatic life protection and human health protection.

Water Quality Control Plan for the San Francisco Bay/Sacramento San Joaquin Delta Estuary

The Bay-Delta WQCP (State Water Resources Control Board 2006) identifies the beneficial uses of the San Francisco Bay/Sacramento–San Joaquin Delta Estuary to be protected, the water quality objectives for reasonable protection of beneficial uses, and a program of implementation for achieving the water quality objectives. Unless otherwise indicated, water quality objectives cited for a general area, such as for the south Delta, are applicable for all locations in that general area, and specific compliance locations are used to determine compliance with the cited objectives within the area. Numeric objectives for chloride are included for the protection of municipal and industrial water supply beneficial uses. Objectives for electrical conductivity (EC) are included for multiple western, interior, and south Delta compliance locations for the protection of agricultural supply beneficial uses. Salinity objectives are also specified for fish and wildlife protection in the form of EC objectives for eastern and western locations within Suisun Marsh, a narrative salinity objective for brackish tidal marshes of Suisun Bay, and the X2 standard that regulates the location and number of days of allowable encroachment into the west Delta of salinity exceeding 2 ppt. In general, the chloride and EC objectives (and Delta inflow/outflow operational objectives) are variable depending on the month of the year and the water year type. EC and DO objectives are included for the protection of fish and wildlife beneficial uses. Additionally, Delta inflow and outflow operational objectives (i.e., Delta outflow, river flows, export limits, and Delta Cross Channel gate operations) are specified for the protection of fish and wildlife beneficial uses. Compliance with salinity objectives in particular is largely dependent on Delta inflows and outflows. The current water quality objectives under this plan are included in Appendix 8A. Currently, the State Water Board isconsidering proposed modifications of San Joaquin River flow criteria for fish and wildlife, the salinity objectives for the south Delta, and the program of implementation for those objectives in the Bay-Delta WQCP (State Water Resources Control Board2011). Potential changes could include modifying the southern Delta salinity objectives as well as the addition of new narrative criteria to ensure adequate water circulation and water levels for the protection of agricultural uses.

Water Quality Control Plan for the Sacramento and San Joaquin River Basins

The Basin Plan for the Sacramento and San Joaquin Rivers defines the beneficial uses, water quality objectives, implementation programs, and surveillance and monitoring programs for waters of the Sacramento and San Joaquin River basins. The Basin Plan contains specific numeric water quality objectives that are applicable to certain water bodies, or portions of water bodies. Numerical objectives have been established for bacteria, DO, pH, pesticides, EC, TDS, temperature, turbidity, and trace metals. The Basin Plan also contains narrative water quality objectives for certain parameters that must be attained through pollutant control measures and watershed management. Narrative water quality objectives also serve as the basis for the development of detailed numerical objectives. The narrative water quality objectives and numeric freshwater criteria/objectives adopted for the Delta are included in Appendix 8A.

Water Quality Control Plan for the San Francisco Bay

The Basin Plan for the San Francisco Bay basin (San Francisco Bay Regional Water Quality Control Board 2007) is similar to the Basin Plan for the Central Valley, as described above, and defines numerical and narrative water quality objectives for the San Francisco Bay (including San Pablo Bay) and portions of the west Delta. The designated beneficial uses for the Delta are consistent with the Central Valley Basin Plan. This Basin Plan contains both freshwater and saltwater criteria for several priority pollutant trace metals. Freshwater objectives apply to waters both lying outside the zone of tidal influence and having salinities lower than 5 ppt at least 75% of the time. Saltwater objectives apply to waters with salinities greater than 5 ppt at least 75% of the time. For waters with salinities in between the two categories, or tidally influenced freshwaters that support estuarine beneficial uses, the objectives are the lower of the freshwater or saltwater objectives, based on ambient hardness, for each substance. Appendix 8A provides the numeric freshwater and saltwater objectives adopted for the Delta.

Water Quality Control Plans Applicable to the State Water Project South of Delta Service Area

The Basin Plans for the Central Coast, Los Angeles, Santa Ana, and San Diego Regional Water Boards similarly define beneficial uses and numeric and narrative water quality objectives for inland and coastal waters and other water bodies in the service areas of SWP contractors that use water from the California Aqueduct and are located generally south of the Central Valley and in the central and southern California coastal counties. In general, the narrative and numeric water quality objectives for inland waters established in these Basin Plans are similar to the Central Valley and San Francisco

Bay Regions. However, because salinity is a primary water quality constituent of concern in the inland and coastal counties of arid southern California, the Basin Plans for these regions all contain specific numeric water quality objectives for salinity constituents (e.g., TDS, hardness, sodium, chloride, and sulfate, among others) for the protection of municipal/domestic and agricultural water supply beneficial uses. The established salinity-based objectives for specific water bodies in these Basin Plans can vary substantially based on specific base level conditions.

Water Quality Control Plans Applicable to Suisun Marsh

Suisun Marsh is located at the northern edge of Suisun Bay, just west of the confluence of the Sacramento and San Joaquin Rivers and is not within the statutory Delta. Suisun Marsh consists of tidal wetlands, sloughs, managed diked wetlands, managed seasonal wetlands, and upland grasslands. The marsh contains approximately 59,000 acres of marsh, managed wetlands, and adjacent grasslands, plus 30,000 acres of open water areas. Most of the managed wetlands are within levee systems with a majority owned by private duck hunting clubs. About 14,000 acres are state-owned and managed by DFG and about 1,400 acres on channel islands are federal lands. Elevation and salinity are the principal factors controlling the distribution of tidal marsh plants in the marsh. Within the diked wetlands, water diversion and release operations are managed to maximize the production of aquatic vascular plants which have traditionally been considered important for wintering waterfowl.

The regulatory framework for managing water quality conditions in Suisun Marsh began in the 1970's with the development of the Suisun Marsh Protection Plan by the Bay Conservation and Development Commission (BCDC), and the adoption of salinity objectives for marsh channels in the 1978 Bay-Delta WQCP to protect the beneficial uses for fish and wildlife. The State Water Board water rights decision (D-1485), applicable to DWR and Reclamation for the management of SWP and CVP operations, was adopted with provisions to meet the Suisun Marsh salinity objectives. DWR's 1984 Plan of Protection for Suisun Marsh was developed to meet the D-1485 requirements and outlined a staged implementation for a combination of proposed physical salinity management *initial facilities*, monitoring, a wetlands management program for marsh landowners, and supplemental releases of water from SWP and CVP reservoirs. In 1987, federal and state agencies adopted the Suisun Marsh Preservation Agreement (SMPA) to mitigate for impacts on marsh salinity from theSWP, CVP, and other upstream diversions. The SMPA identified the schedule for construction of the large-scale facilities in Suisun Marsh that would enable the salinity objectives to be met. The 1991 Bay-Delta WQCP increased the number of locations in the marsh to seven where numerical salinity objectives were to be met. The 1994 Principles of Agreement on Bay-Delta Standards (Bay-Delta Accord that formed CALFED), the 1995 Bay-Delta WQCP, and the adoption of D-1641 in 1999, all resulted in refinements to the Suisun Marsh salinity standards, added narrative salinity objectives for the tidal marshes of the surrounding Suisun Bay, and mandated the formation of a Suisun Marsh Ecological Work Group which would provide recommendations for water quality objectives to improve conditions for beneficial uses (i.e., wildlife habitat, rare, threatened and endangered species, and estuarine habitat), and recommend future research and monitoring needs for the marsh. Due to evidence showing a potential for actions to meet the salinity objectives at two compliance stations within the marsh might cause harm to the beneficial uses they were intended to protect, the State Water Board in D-1641 did not require that DWR and Reclamation attain the objectives at these stations. The salinity objectives for the marsh remained unchanged in the 2006 Bay-Delta WQCP, however, it identifies that salinity objectives will be finalized, including adoption of numerical objectives for brackish marshes in Suisun Bay and other locations (if necessary), by 2015 and following development and implementation of a comprehencive Suisun Marsh Plan. Federal and state agencies recently completed environmental compliance documentation for the Suisun Marsh Plan (Bureau of Reclamation et al. 2011), which assesses a comprehensive 30-year plan designed to address use of resources within about 52,000 acres of wetland and upland habitats in the marsh, restoration of tidal wetlands, and the enhancement of managed wetlands and their functions.

The Suisun Marsh Salinity Control Gates (SMSCG) were constructed on Montezuma Slough near Collinsville and began operating in late 1988. The gates are periodically operated from September to May to meet the salinity standards of the 1995 Bay-Delta WQCP and D-1641 requirements. The SMSCG operation acts to restrict the inflow of high salinity flood tide water from Grizzly Bay into the marsh but allow passage of freshwater ebb tide flow from the mouth of the Delta. Operation of the gates in this fashion lowers salinity in Suisun Marsh channels and results in a net movement of water from east to west. When Delta outflow is low to moderate and the gates are not operating, net movement of water is from west to east, resulting in higher salinity water in Montezuma Slough. Because the SMSCG operations have been more effective than anticipated, and as a result of additional freshwater Delta outflows required by the 1995 Bay-Delta WQCP, other previously proposed large physical facilities to promote further salinity controls in the marsh have not been implemented. The SMSCG are operated only as needed and do not generally operate from June through August.

Other Water Quality Plans

The State Water Board has begun development of a statewide mercury regulatory program to address reservoirs on the state's 303(d) list for mercury. The plans are currently at the scoping level, as of first quarter 2012.

California Drinking Water Standards Incorporated by Reference in Basin Plans

Both the Central Valley and San Francisco Bay Basin Plans incorporate by reference the California Department of Public Health (DPH) numerical drinking water maximum contaminant levels (MCLs). The incorporation of the MCLs, which are applicable to treated drinking water systems regulated by DPH, makes the MCLs also applicable to ambient receiving water with respect to the regulatory programs administered by the Regional Water Boards. DPH establishes state drinking water standards, enforces both federal and state standards, administers water quality testing programs, and issues permits for public water system operations. The drinking water regulations are found in Title 22 of the California Code of Regulations (CCRs). The state drinking water standards consist of primary and secondary MCLs. Primary MCLs are established for the protection of environmental health, and secondary MCLs are established for constituents that affect the aesthetic quality of drinking water, such as taste and odor. The incorporation by reference of the MCLs in Basin Plans is meant to ensure, to the extent possible, that adequate source water quality is maintained to support the domestic and municipal water supply beneficial use, particularly from constituents for which water treatment plants are not typically designed to remove. The state primary and secondary MCLs applicable to the Central Valley and San Francisco Bay Basin Plans are provided in Appendix 8A.

8.1.1.7 Water Quality Impairments

Water Quality Limited Water Bodies, Watershed Monitoring Programs, and Total Maximum Daily Loads

Constituents of concern in the project area have been identified through ongoing regulatory, monitoring, and environmental planning processes. Important programs are CALFED, the Basin Plan functions of the Central Valley and San Francisco Bay Regional Water Boards, Bay-Delta planning functions of the State Water Board, and the CWA Section 303(d) listing process for state water bodies that do not meet applicable water quality objectives.

The CALFED Bay-Delta Program was established in 1995 to develop a long-term comprehensive plan to restore ecological health and improve water management for beneficial uses of the Bay-Delta System. Senate Bill 1653 established the California Bay Delta Authority to act as the governance structure, as of January 1, 2003, which is housed within the California Resources Agency.

Under CWA Section 303(d), states, territories, and authorized tribes are required to develop a ranked list of water-quality limited segments of rivers and other water bodies under their jurisdiction. Listed waters are those that do not meet water quality standards, even after point sources of pollution have installed the minimum required levels of pollution control technology. The law requires that action plans, or TMDLs, be developed to monitor and improve water quality. TMDL is defined as the sum of the individual waste load allocations from point sources, load allocations from nonpoint sources and background loading, plus an appropriate margin of safety. A TMDL defines the maximum amount of a pollutant that a water body can receive and still meet water quality standard. TMDLs can lead to more stringent NPDES permits (CWA Section 402).

The State Water Board recently compiled the 2010 Section 303(d) list of impaired waters based on recommendations from the Regional Water Boards and information solicited from the public (and other interested parties). In October 2011, USEPA gave final approval to the list. Table 8-2 lists the constituents identified in the Section 303(d) list for impaired Delta waters (State Water Resources Control Board 2011).

Table 8-2. Clean Water Act Section 303(d) Listed Pollutants and Sources for the Project Area

Pollutant/Stressor	Listing Region	Listed Source	Delta Location of Listing
Boron	Central Valley	Agriculture	Exp
Chlordane	Central Valley and San Francisco Bay	Agriculture, Nonpoint Source	N, W
Chloride	Central Valley	Source Unknown	TomP
Chloropyrifos	Central Valley	Agriculture, Urban Runoff/Storm Sewers	N, S, E, W, NW, C, Exp, Stk, CalvR, Duck, Five, French, MokR, Morm, Mosh, OldR, Pix
Copper	Central Valley	Resource Extraction	MokR
DDT	Central Valley and San Francisco Bay	Agriculture, Nonpoint Source	N, S, E, W, NW, C, Exp, Stk
Diazinon	Central Valley	Agriculture, Urban Runoff/Storm Sewers	N, S, E, W, NW, C, Exp, Stk, CalvR, Five, French, Mosh, Pix,

Pollutant/Stressor	Listing Region	Listed Source	Delta Location of Listing
Dieldrin	San Francisco Bay	Nonpoint Source	N, W
Dioxin Compounds	Central Valley and San Francisco Bay	Source Unknown, Atmospheric Deposition	W, Stk
Disulfoton	Central Valley	Agriculture	Pix
E. Coli	Central Valley	Source Unknown	E, French, Pix
Invasive Species	Central Valley and San Francisco Bay	Source Unknown, Ballast Water	N, S, E, W, NW, C, Exp, Stk
Furan Compounds	Central Valley and San Francisco Bay	Contaminated Sediments, Atmospheric Deposition	Stk
Group A Pesticides[a]	Central Valley	Agriculture	N, S, E, W, NW, C, Exp, Stk
Mercury	Central Valley and San Francisco Bay	Resource Extraction, Industrial-Domestic Wastewater, Atmospheric Deposition, Nonpoint Source	N, S, E, W, NW, C, Exp, Stk, CalvR, MokR, Mosh
Pathogens	Central Valley	Recreational and Tourism Activities (nonboating), Urban Runoff/Storm Sewers	Stk, CalvR, Five, Morm, Mosh, Walk
PCBs	Central Valley and San Francisco Bay	Source Unknown	W, N, Stk
Unknown Toxicity[b]	Central Valley	Source Unknown	N, S, E, W, NW, C, Exp, Stk, French, MokR, Morm, Pix
EC	Central Valley	Agriculture	S, W, NW, Exp, Stk, OldR, TomP
Organic Enrichment/Low DO	Central Valley	Municipal Point Sources, Urban Runoff/Storm Sewers	Stk, CalvR, Five, MidR, MokR, Morm, Mosh, OldR, Pix, TomP
Sediment Toxicity	Central Valley	(not specified)	French
Selenium	San Francisco Bay	Refineries, Invasive Species, Natural Sources	W
TDS	Central Valley		S, OldR
Zinc	Central Valley	Resource Extraction	MokR

Source: State Water Resources Control Board 2011.

a Group A pesticides include aldrin, dieldrin, chlordane, endrin, heptachlor, heptachlor epoxide, benzene hexachloride (BHC; including lindane), endosulfan, and toxaphene.

b Toxicity is know to occur, but the constituent(s) causing toxicity is unknown.

Notes: DDT = dichlorodiphenyltrichloroethane, PCB = polychlorinated biphenyls.

Delta Locations: C = Central, E = East, Exp = export area, N = north, NW = northwest, S = south, Stk = Stockton Ship Channel, W = west (includes Central Valley list and San Francisco Bay list for "Bay-Delta" category).

Specific Delta Waterways: CalvR = Calaveras River, Duck = Duck Slough, Five = Five Mile Slough, French = French Camp Slough, MidR = Middle River, MokR = Mokelumne River, Morm = Mormon Slough, Mosh = Mosher Slough, OldR = Old River, Pix = Pixley Slough, TomP = Tom Paine Slough, Walk = Walker Slough.

There are several ongoing watershed-monitoring programs in the project area. These monitoring programs are associated with Section 303(d) TMDL programs, the State Water Board Surface Water Ambient Monitoring Program, and numerous other efforts of local governments and public/private entities.

Section 303(d) requires that states evaluate and rank water quality impairments that cannot be resolved through point source controls and, in accordance with the priority ranking, the TMDL for those pollutants which the EPA identifies under section 304(a)(2) as suitable for such calculation. The TMDL must be established at a level necessary to implement the applicable water quality standards with seasonal variations and a margin of safety which takes into account any lack of knowledge concerning the relationship between effluent limitations and water quality. The TMDL is the amount of loading that the water body can receive and still meet water quality standards. The TMDL must include an allocation of allowable loadings to point and nonpoint sources, with consideration of background loadings. Table 8-3 summarizes the TMDLs that have been completed or are currently being developed for Section303(d) listed constituents in the Delta, and the portion of the project area in the Sacramento and San Joaquin River basins (Central Valley Regional Water Quality Control Board 2009c).

Table 8-3. Summary of Completed and Ongoing Total Maximum Daily Loads in the Bay-Delta and Sacramento and San Joaquin Rivers Portions of the Project Area

Pollutant/Stressor	Water Bodies Addressed	TMDL Status
Chlorpyrifos and Diazinon	Sacramento County Urban Creeks	TMDL report completed – September 2004 State-Federal approval – November 2004
Chlorpyrifos and Diazinon	Lower San Joaquin River	TMDL report completed – October 2005 State-Federal approval – December 2006
Chlorpyrifos and Diazinon	Sacramento and San Joaquin Rivers and Delta	TMDL report completed – June 2006 State-Federal approval – October 2007
Chlorpyrifos and Diazinon	Sacramento and Feather Rivers	TMDL report completed – May 2007 State-Federal approval – August 2008
Chlorpyrifos and Diazinon	Lower San Joaquin River	TMDL report completed – October 2005 State-Federal approval – December 2006
DO	Stockton Deep Water Ship Channel	TMDL report completed – February 2005 State-Federal approval – January 2007
Mercury/Methylmercury	Delta	TMDL report completed – April 2010
Pathogens	Tributaries affected by City of Stockton urban runoff	Ongoing
Pesticides	Basin-wide	Ongoing
Organochlorine Pesticides	Specific Sacramento and San Joaquin River tributaries; Delta	Ongoing
Salt and Boron	San Joaquin River at Vernalis	TMDL report completed – October 2005 State-Federal approval – February 2007
Selenium	San Joaquin River at Vernalis	TMDL report completed – August 2001 State-Federal approval – March 2002

Source: Central Valley Regional Water Quality Control Board 2009c.
Notes: TMDL = Total Maximum Daily Load

Table 8-4 summarizes only the total number of Section 303(d) listed water bodies in the regions of the Central Coast, Los Angeles, Santa Ana, and San Diego Regional Water Boards where SWP south of Delta exports are conveyed. This information is presented at a lesser level of detail than for the Delta and Sacramento–San Joaquin regions because the effects of storage and conveyance of Delta export water in the southern SWP service areas to the large majority of these listed water bodies is only indirect or nonexistent. Moreover, not all of the Section 303(d)-listed water bodies in these regions necessarily occur in the SWP service areas because the SWP service areas do not cover the entire regions.

Table 8-4. Clean Water Act Section 303(d) Listed Water Bodies in Regions of the Project Area Served by SWP South of Delta Exports

	Regional Water Board				
Pollutant	San Francisco	Central Coast	Los Angeles	Santa Ana	San Diego
Hydromodification			10		
Mercury	36	6	11	2	2
Other Metals	27	44	142	24	159
Miscellaneous	17	147	52	11	36
Nuisance		3	27		14
Nutrients	15	321	183	29	179
Other Inorganics	2		39		14
Other Organics	64	11	102	10	18
Pathogens	32	451	171	44	324
Pesticides	95	142	187	16	32
Salinity	1	194	72	2	46
Sediment	10	168	23	10	20
Toxicity	7	105	49	8	109
Trash	27		87		7

Source: State Water Resources Control Board 2011.

8.1.1.8 Water Quality Constituents of Concern

Constituents that are of concern in the project area are those that, at elevated concentrations, have the potential to adversely affect or impair one or more beneficial uses (Table 8-1) such as the constituents identified from the Section 303(d) listing process described above (Tables 8-1 and 8-2).

Salinity is an important parameter of concern for the Delta which reflects the total ionic content of the water, ranging from very low levels deemed freshwater to the high salinity content of seawater. Chloride, bromide, sulfate, and boron are specific ions that contribute to overall salinity and are constituents of concern. Salinity can affect multiple beneficial uses, including defining the types and distribution of aquatic organisms that are adapted to freshwater versus brackish, or saline, water conditions in the Delta.

Other constituents of concern for the Delta in particular are of importance to municipal water suppliers including organic carbon (total and dissolved) and bromide which are precursors for the formation of disinfection byproducts (DBPs) such as trihalomethanes (THMs), haloacetic acids (HAAs), bromate, chorite, and nitrosamines at treated drinking water treatment processes. Of note, if organic carbon was not chlorinated, or bromide was not present, the risk of DBP formation at drinking water plants would be greatly reduced. Pathogens are of importance to municipal water suppliers as well as recreational uses.

In addition, elevated nutrient concentrations can affect municipal water suppliers that store diverted Delta water in reservoirs. Elevated nutrient levels contribute to algae growth and affect the taste of treated water, filter clogging at water treatment plants, and increased levels of organic carbon. Increased salinity concentrations can also alter the taste of finished drinking water.

Constituents of concern to agricultural users of the project area include boron and salinity. Many crops are sensitive to these constituents, which can affect their yield.

Numerous constituents can cause adverse effects on aquatic life of the project area, including temperature, turbidity and suspended sediment, DO, pesticides, herbicides, and trace metals. Trace metals, pesticides, and herbicides can be toxic to aquatic life at relatively low concentrations. Temperature and DO are of concern because the Delta serves as a migration and rearing corridor for anadromous salmonids, which are sensitive to these parameters.

Finally, an emerging class of constituents of concern is endocrine-disrupting compounds (EDCs) and pharmaceutical and personal care products (PPCPs). EDCs and PPCPs are thought to have the potential to cause adverse effects on aquatic resources, and their potential presence in drinking water supplies has received significant attention (World Health Organization 2002; U.S. Geological Survey 2002).

As noted in Table 8-2, the entire Delta is identified on the Section 303(d) list as impaired by unknown toxicity. Aquatic toxicity refers to the mortality of aquatic organisms or sublethal (e.g., growth, reproductive success) effects. Aquatic toxicity can be caused by any number of individual constituents of concern, or through additive and synergistic effects attributable to the presence of multiple toxicants. No TMDLs have been developed for the Delta to address the sources of toxicity, identify alternatives to reduce toxicity, or to identify the allocation of the allowable loading of constituents that would result in achieving the Basin Plan narrative *toxicity* objective that forms the basis for the Section 303(d) listing. Because unknown toxicity is a primary concern for fisheries and other aquatic organisms, Chapter 11, *Fish and Aquatic Resources*, addresses the subject in detail [*Note to Lead Agencies: This section in Chapter 11 is in preparation*].

In light of these issues, the constituents of concern identified in Table 8-5 are addressed in detail for the purposes of characterizing existing water quality within the project area (Section 8.1.3, *Existing Water Quality*), and to support the water quality impact assessments. Table 8-5 also relates the constituents of concern to the various receptors in the project area that could be adversely affected by their concentrations. For the purposes of this characterization, the receptors are categorized by the designated beneficial uses specified in the Bay-Delta WQCP. The constituent-specific sections described subsequently (Section 8.1.3) characterize the potential effects on beneficial uses and various receptors, including known information regarding specific locations in the Delta most affected by the constituents.

8.1.2 Selection of Monitoring Locations for Characterization of Water Quality

8.1.2.1 Water Quality Monitoring Programs and Sources of Data

In compiling water quality data for the 16 constituents of concern (Table 8-5), data sets from the following monitoring programs were initially obtained through the Bay-Delta and Tributaries Project (BDAT) for the period from 1990 through 2009 (Bay-Delta and Tributaries Project 2009).

- California National Water Information System Water Quality Data (U.S. Geological Survey [USGS]).
- Environmental Monitoring Program (DWR) (continuous and discrete data).
- Municipal Water Quality Investigations Program (DWR).
- Surface Water Ambient Monitoring Program (State Water Board and Regional Water Boards).

BDAT contains environmental data concerning the Bay-Delta and provides public access to that data. Over 50 organizations voluntarily contribute biological, water quality, meteorological and other data to this database . In the event the monitoring programs listed above, as accessed through BDAT, did not provide data for all the constituents of interest, additional data were obtained from one or more of the following monitoring programs/databases to fill in the data and provide a more comprehensive characterization of Delta water quality.

- California Data Exchange Center (DWR).
- Interagency Ecological Program (multiagency).
- National Water Information System (USGS).
- San Francisco Estuary Institute (SFEI; multi-agency in Bay Area).
- Sacramento River Coordinated Monitoring Program (City and County of Sacramento).
- Sacramento River Watershed Program (nonprofit 501[c][3] organization).
- Water Data Library (DWR).

8.1.2.2 Surface Water Quality Monitoring Locations

Based on data availability, data continuity, and geographic location, a total of 20 water quality monitoring stations were selected to characterize the water quality conditions in the project area. Because of the complexity of the Delta environment, a detailed characterization of water quality was necessary for the statutory Delta to represent the effects of water quality to the broad beneficial use categories (e.g., agriculture, aquatic life, recreation) and more specific issues such as major water diversion locations. For example, major water diversions include CCWD's three intakes at Rock Slough, Old River, and Victoria Canal; the North Bay Aqueduct; Jones and Banks pumping plants; seasonal Antioch and Mallard Slough diversions; and the City of Stockton's new diversion from the central Delta. The following section provides a brief illustration of how the data from these stations were used to represent various parts of the project area. Table 8-6 presents the specific reasons for selecting these locations.

Table 8-5. Receptors Affected by Water Quality – Characterized by the Designated Beneficial Uses of the Project Area

Constituent	Freshwater Replenishment	Municipal and Domestic Supply and Groundwater Recharge	Agricultural Supply	Industrial Process Supply	Recreation: Contact	Recreation: Non-Contact	Shellfish Harvesting and Aquaculture	Commercial/ Sport Fishing	Freshwater Habitat: Warm	Freshwater Habitat: Cold	Migration/ Spawning	Estuarine Habitat	Wildlife Habitat	Endangered Species and Areas of Biological Significance
Physical Parameters														
Temperature							X	X	X	X	X	X		X
Turbidity/Suspended Solids	X	X		X	X	X			X	X	X			
Inorganic Parameters														
Salinity (EC/TDS)	X	X	X	X			X	X	X	X	X	X	X	X
Bromide	X	X												
Chloride	X	X	X	X			X	X	X	X	X	X	X	X
Boron	X		X											
Organic Carbon	X	X												
Ammonia (nitrogen)		X					X	X	X	X	X	X		X
Other Nutrients (nitrogen, phosphorus)	X	X					X	X	X	X	X	X	X	X
DO							X	X	X	X	X	X		X
Trace Metals														
Mercury	X	X					X	X	X	X	X	X	X	X
Selenium			X						X	X	X	X	X	X
Others (e.g., copper, lead, zinc,.)	X	X					X	X	X	X	X	X		X
Pathogens														
Pathogens	X	X			X		X	X						
Organic Compounds														
Pesticides and Herbicides	X	X					X	X	X	X	X	X	X	X
Dioxins/Furans and PCBs	X	X					X	X	X	X	X	X	X	X
Polycyclic Aromatic Hydrocarbons	X	X					X	X	X	X	X	X	X	X
Emerging Pollutants (EDCs/PPCPs)	X	X					X	X	X	X	X	X	X	X
Applicable Basin Plan	N, S, Exp	D, N, S, Exp	D, N, S, Exp	D, N, S, Exp	D, N, S, Exp		D, N, S, Exp	D, N, S, Exp	D, N, S, Exp		D, N, S, Exp	D	D, N, S, Exp	D, N, S, Exp

Notes:

D = Delta
EDC = endocrine-disrupting compound
Exp = export area
N = north
PCB = polychlorinated biphenyl
PPCP = pharmaceutical and personal care product
S = south

Table 8-6. Locations Selected to Represent Existing Water Quality in the Delta

Location	Data Sources	Justification for Selecting Location
North of Delta Locations		
Sacramento River at Keswick	DWR	Characterizes water quality in the area north of the Delta
Feather River at Oroville	DWR	Characterizes water quality in the area north of the Delta
American River at the E.A. Fairbairn Water Treatment Plant	DWR	Characterizes water quality in the area north of the Delta
Sacramento River at Verona	DWR	Characterizes water quality in the area north of the Delta
Delta Source Water Locations		
Sacramento River at Hood	BDAT, CDEC, MWQI	Characterizes water quality at the northern boundary of the Delta
San Joaquin River near Vernalis	BDAT, CDEC, MWQI	Characterizes water quality at the southern boundary of the Delta
Mokelumne River (South Fork) at Staten Island	BDAT, WDL	Characterizes EC from a major eastern Delta boundary river
Suisun Bay at Bulls Head Point near Martinez	BDAT	Characterizes water quality at the western export area of the Delta; represents saltwater intrusion into the Delta
Delta Interior		
San Joaquin River at Buckley Cove	BDAT	Represents effects of Stockton Deep Water Ship Channel in the eastern Delta near the City of Stockton
Franks Tract at Russo's Landing	BDAT	Characterizes water quality in a reclaimed area in the central portion of the Delta
Old River at Rancho del Rio	BDAT	Characterizes water quality in the central portion of the Delta
Major Outflows		
Sacramento River above Point Sacramento	BDAT, SFEI	Characterizes Sacramento River water quality prior to its confluence with the San Joaquin River; essentially the same location as the SFEI's BG20 station
San Joaquin River at Antioch Ship Channel	BDAT, SFEI	Characterizes San Joaquin River water quality prior to its confluence with the Sacramento River; essentially the same location as the SFEI's BG30 station
Sacramento River at Mallard Island	MWQI	Characterizes water quality at the western boundary of the Delta; essentially the same location as Sacramento River at Chipps Island
Major Diversions		
North Bay Aqueduct at Barker Slough Pumping Plant	CDEC, MWQI	Major municipal water supply intake in northwestern portion of the Delta
Contra Costa Pumping Plant No. 1	MWQI	Major municipal water supply intake in western portion of the Delta
Harvey O. Banks Pumping Plant	CDEC, MWQI	Major water supply intake; pumps SWP water into the California Aqueduct
C. W. "Bill" Jones Pumping Plant	BDAT, CDEC, MWQI	Major water supply intake; pumps CVP water into the Delta-Mendota Canal
South of Delta Locations		
California Aqueduct at Check 13	DWR	Characterizes water quality in the area south of the Delta
California Aqueduct at Check 29	DWR	Characterizes water quality in the area south of the Delta

Notes: BDAT = Bay Delta and Tributaries Project; CDEC = California Data Exchange Center; DWR = California Department of Water Resources; EC = electrical conductivity; MWQI = Municipal Water Quality Investigations; SFEI = San Francisco Estuary Institute; WDL = Water Data Library; WTP = water treatment plant

North of Delta

The hydrology north of the Delta is dominated by three major rivers—the Sacramento, Feather, and American. To characterize the water quality for the area north of the Delta, it is important to review the water quality entering these three rivers from their major reservoirs (Shasta Lake, Lake Oroville, and Folsom Lake, respectively). For the purpose of this assessment, the water quality of the area north of Delta is represented by locations downstream of these three lakes, as well as a monitoring location at the Sacramento River at Verona (immediately downstream of the confluence of the Feather and Sacramento Rivers, representing the water quality of the combined flow after mixing) Figure 8-9 shows the selected locations.

- Sacramento River at Keswick.
- Feather River at Oroville.
- American River at the E. A. Fairbairn Water Treatment Plant.
- Sacramento River at Verona.

Because organic carbon data were not monitored at the Verona location, data from a monitoring location approximately 9 miles downstream of the Verona location (Sacramento River at Veteran's Bridge [Interstate 5]) was reviewed and analyzed for organic carbon. Water quality downstream of the confluence of American and Sacramento Rivers is represented by the monitoring station at Hood, which is addressed in the following section, *Delta Source Waters*.

8.1.2.3 Delta Source Waters

Water quality in the Delta at any given location and time is primarily the result of the sources of water to that location (i.e., the percentage of the water at the site comprising water from the Sacramento River, the San Joaquin River, eastside tributaries, Bay water, in-Delta runoff, and agricultural return flows). Consequently, it is important to characterize the quality of the major sources of water entering the Delta to determine how Delta water quality may change, as the source fractions of water to various locations change with implementation of alternative activities. For the purpose of this section, the water quality of the major Delta source waters will be represented by the following locations.

- Sacramento River at Hood.
- San Joaquin River at Vernalis.
- Mokelumne River at Staten Island.
- Bay water intrusion to Suisun Bay at Martinez.

Figure 8-10 shows the selected locations. It should be noted that the selected Sacramento, San Joaquin, and Mokelumne Rivers monitoring stations are within the statutory Delta and can be affected by tidal action, depending on the streamflow rates. Additionally, the Mokelumne River is directly affected by the flow of Sacramento River water when the Delta Cross Channel is open. However, these locations generally represent the water quality occurring at these perimeter locations in the Delta.

Interior Delta and Outflow L ocations

In addition to characterizing the quality of the major source water inputs to the Delta, a number of interior Delta locations were identified for characterizing existing interior Delta water quality. The locations chosen for this purpose were selected based on the following criteria.

- Availability of water quality data (i.e., locations used by the various water quality monitoring programs).
- Geographic location in the Delta, in an effort to have one or more stations within the northern, central, eastern, western, and southern portions of the Delta.
- Locations of the primary water supply intakes.
- Bay-Delta WQCP EC compliance locations.
- Other related considerations (e.g., locations of output nodes for Delta Simulation Model 2 (DSM2), reasonable number of locations to support the water quality impact assessments).

Based on the selection criteria listed above, ten interior and outflow Delta locations were chosen (Figure 8-10) for the purposes of characterizing existing water quality in the Delta and to support the water quality impact assessments.

South of the Delta

The system south of the Delta is primarily influenced by the numerous dams and reservoirs and hundreds of miles of canal that constitute the SWP and CVP (described previously). The SWP and CVP serve as the primary source of municipal water supply and also serve as one of the major sources of agricultural water supply. Forthe purpose of this assessment, the water quality of the area south of the Delta is represented by two locations along the California Aqueduct.

- California Aqueduct at Check 13.
- California Aqueduct at Check 29.

Figure 8-11 shows the selected locations for the area south of the Delta.

The San Luis Reservoir is a major storage reservoir 50 miles south of the Delta that is used for various control purposes within the system (e.g., storing water from the San Joaquin River and Sacramento River to re-release into the aqueducts). Hence, the water quality downstream of this reservoir is of great importance in characterizing the water quality in the service area. Water exiting the San Luis Reservoir passes through the O'Neill Forebay, which is also fed by water from the California Aqueduct and the Delta-Mendota Canal. The water quality monitoring location at the exit point of the O'Neill Forebay is called the California Aqueduct at Check 13.

South of O'Neill Forebay, there are inflows to the aqueduct, including stormwater and flood flows at crossings of several streams, and groundwater inflows, prior to water being pumped over the Tehachapi Mountains and into watersheds of water supply reservoirs in the Los Angeles region and areas to the south. DWR accepts the introduction of local groundwater into the aqueduct (i.e., "Pump-In" Projects) in accordance with California Water Code provisions that state that nonproject water may be conveyed, wheeled, or transferred in the SWP provided that water quality is protected.

8.1.3 Existing Surface Water Quality

In the following subsections, each constituent of concern (or category of similar constituents) are reviewed in detail to characterize the general patterns of concentrations that exist in the project area at present. The review process followed the steps outlined below.

- Literature review – A wide range of scientific articles, agency reports, and site-specific studies were reviewed to collect the following information.
  - The various structural and nonstructural features and operations in the project area that affect water quality.
  - The importance and relevance of each of the constituents of concern in the project area.
  - The interaction of various constituents and the combined effect on water quality.
  - The historic and current patterns in concentrations of the constituents at selected locations.
  - The variation in concentrations in wet and dry years
  - Applicable standards and regulatory criteria, and known impairments.
- Some of the key documents reviewed include the following.
  - Basin Plan for the Sacramento and San Joaquin River Basins.
  - Basin Plan for the San Francisco/San Joaquin Delta Estuary (Bay-Delta WQCP).
  - WQCP for the Sacramento-San Joaquin Delta.
  - CALFED Bay-Delta Program 2000 Water Quality Program Plan.
  - CALFED 2008 State of Bay Delta Science.

Water quality data for the identified constituents were collected from various monitoring programs and databases. Data were downloaded for selected locations (described in previous section) for each of the constituents for the period between 1990 and present, and stored in a database. In the discussions below, various periods of record are discussed for different constituents and different purposes. The time period of data used to characterize present conditions varied by constituent according to what was available in the database, but in general, data from 2001-2006 are presented as a representative, recent time period that contained both wet and dry years and for which data was available for the entirety of all water years. Appendix 8B summarizes the data availability for each of the constituents of concern and locations where substantial information exists for characterizing the existing conditions. A user-friendly application was developed to analyze the water quality data and determine spatial and temporal patterns. Depending on the availability of data, the information was presented in various forms.

- Spatial distribution – data presented in a map for individual constituents identifying the location of the sampling station; the date range; and the maximum, minimum, average, and median values.
- Seasonal patterns – plots showing the change in concentrations over time.
- Tabular – tables showing concentrations of constituents where data are discrete or discontinuous.

8.1.3.1 Salinity and Electrical Conductivity

Background

Salinity is the concentration of dissolved salts in water. Typical salts found include the major cations (calcium, magnesium, sodium, and potassium) and anions (sulfate, chloride, fluoride, bromide, bicarbonate, and carbonate). The relative proportion of the anions and cations are different in typical freshwater and seawater, with sodium and chloride dominating seawater salinity. The composition of dominant cations and anions in freshwater can vary to a much greater degree. Salinity can be measured in a variety of ways, including chloride concentration, TDS concentrations, or EC. While a recognized international measurement scale of salinity exists (i.e., Practical Salinity Units), the term is not commonly used and the measured parameters EC and TDS are more often used interchangeably to refer to generalized effects of salinity. The beneficial uses most affected by salinity concentrations include municipal, agricultural, and industrial water supply.

Additionally, changes in salinity, including tidally influenced interfaces between freshwater and saltwater in the Delta, directly affect aquatic organismsand indirectly affect aquatic and wildlife habitats (i.e., warm freshwater habitat, cold freshwater habitat, estuarine habitat). Related beneficial uses such as commercial and sport fishing and shellfish harvesting are also affected.

EC is often used to measure salinity because a simple electronic probe can measure salinity directly in the field and be recorded at frequent intervals (e.g., every 15 minutes), making it a cost-effective measurement. Other measures require field collection of water samples and laboratory analysis, which can be expensive. EC units commonly used are micromhos/cm (μmhos/cm) and milliSiemens/cm (mS/cm), and both are measures of the conductivity of the water.

Salinity can originate from natural sources such as seawater and rainfall-induced leaching of salts from soils. Anthropogenic sources of salinity include drainage from irrigated agricultural lands and managed wetlands, agricultural chemical soil additives, municipal and industrial wastewater discharges, and urban stormwater. Salinity also increases through evaporative concentration, which occurs during the dry, warm months of the year in water that is diverted and conveyed in canals and ditches, stored in reservoirs, and applied to land for crop irrigation in excess such that direct runoff occurs to drainage ditches.

Importance in the Project Area

Concern about salinity involves three main issues: drinking water, crop irrigation, and biota/habitat. Elevated concentrations of salinity result in poor-tasting water, and also limit the ability of wastewaters to be recycled for nonpotable uses (e.g., landscape irrigation). The TDS concentration of water from Sierra Nevada streams is typically less than 100 mg/L, while drinking water from the Delta typically has TDS concentrations from 150 to 300 mg/L, with concentrations occasionally exceeding 500 mg/L (CALFED Bay-Delta Program 2007a). Bromide, a compound of ocean salts, is a precursor to the formation of DBPs in drinking water facilities, which can be harmful to humans and animals (see further in this section for a detailed discussion of bromide). In addition, industrial processes that require low-salinity water can also be negatively affected. Salt removal during the water purification process (for either drinking or process water)is presently very expensive.

When salinity concentrations in irrigation water are too high, yields for salt-sensitive crops may be reduced. Salinity can also decrease water available to the plant and cause plant stress (CALFED Bay-Delta Program 2007a). There are also fish, wildlife, and aquatic plant species that have adapted to naturally occurring salinity ranges in the Bay-Delta system, with specific salinity requirements at certain life stages in order to survive. There isevidence to suggest that the artificial stabilization of salinity, which has been undertaken in the Delta to maximize drinking and agricultural water quality, may create habitat more suitable for invasive rather than for native species (Lund et al. 2007).

The primary source of salinity in the Delta is seawater intrusion from the west (CALFED Bay-Delta Program 2000). Salinity also is elevated in the San Joaquin River inflows as a result of irrigated agricultural drainage on southern San Joaquin Valley soils of marine origin that are naturally high in salts, and from recirculation of salt in Delta waters that are used for irrigation via the Delta-Mendota Canal and returned back to the Delta. From a broad viewpoint, salinity is determined as interplay between the amount of freshwater entering the Delta from the major tributaries (e.g., Sacramento and San Joaquin Rivers) and seawater from San Francisco Bay. During the late winter and spring months of seasonally elevated runoff and flows, and in particular during wet years with high levels of runoff from interior California, the elevated freshwater flows limit the extent of seawater intrusion into the Delta from the Bay. During low-flow summer and fall months, and dry water year types with low levels of runoff, the lower freshwater flows result in greater amounts of seawater intrusion (Figures 8-6 and 8-7). Maximum salinity intrusions into the Plan Area from the Bay are greatest during low precipitation years.

The volume of Delta channels subject to daily tidal action is also an important factor affecting the extent of high-salinity seawater intrusion and also influences the behavior of saline water once in the Delta. Increases in channel volume associated with levee failures on Delta islands (Mierzwa and Suits 2005) can result in daily tidal exchange moving considerably farther inland compared to conditions with the island levees intact. The June 2004 failure of a levee at Jones Tract, which flooded both upper and lower Jones Tract, resulted in substantial increased salinity conditions in the southern and central Delta (Mierzwa and Suits 2005).

The description of salinity in the Delta provided above is intended as an overview; salinity in the Delta can vary greatly in time and space (CALFED Bay-Delta Program 2007a) with many contributing factors, including the following.

- Hydrology (precipitation and runoff).
- Water operations (reservoir releases, channel barrier operations, diversion pumping rates).
- Watershed sources (agriculture, managed wetlands, natural leaching, recirculation of Delta salinity, municipal and industrial discharges).
- Hydrodynamics (geometry of water bodies, meteorology, salinity gradients, freshwater inputs, tidal action).

Existing Conditions in the Project Area

During the water year 2001–2006 period, mean EC concentrations tended to increase from the northern Delta to the southern Delta, and from the eastern Delta to the western Delta (Figure 8-12). For example, EC mean concentrations in the northern Delta were 166 and 141 micro mhos per centimeter (µmhos/cm) for the Sacramento River at Hood and the Mokelumne River (South Fork) at Staten Island, respectively. In the southern Delta region, EC mean concentrations were 590 and 673 µmhos/cm for the San Joaquin River at Buckley Cove and the San Joaquin River near Vernalis, respectively. As water exits the Delta, mean EC concentrations were 3,481 and 2,366 µmhos/cm for the Sacramento River above Point Sacramento and the San Joaquin River at Antioch Ship Channel, respectively. Mean EC concentrations increased to 4,920 µmhos/cm at the Sacramento River at Mallard Island, and were highest at Suisun Bay at Bulls Head Point near Martinez, with a value of 19,331 µmhos/cm.

Mean values for the north of Delta area were lower than in the Delta region, ranging from 65 µmhos/cm at the American River at the water treatment plant (WTP) to 120 µmhos/cm at the Sacramento River at Verona (Table 8-7). South of Delta mean values were higher than those for the north of Delta stations examined (439 to 460 µmhos/cm), and slightly higher than the mean at the Harvey O. Banks headworks (393 µmhos/cm, Figure 8-12).

Table 8-7. Electrical Conductivity Concentrations at Selected North and South of Delta Stations, Water Years 2001–2006

	Electrical Conductivity (µmhos/cm)				
Location	Samples	Minimum	Maximum	Mean	Median
Sacramento River at Keswick	32	82	127	106	108
Sacramento River at Verona	15	92	148	120	117
Feather River at Oroville	29	53	239	86	83
American River at WTP	120	6	152	65	65
California Aqueduct at Check 13	69	217	981	460	465
California Aqueduct at Check 29	74	133	680	439	456

Sources: California Department of Water Resources 2009b.
Notes: µmhos/cm = micro mhos per centimeter; WTP = water treatment plant
[a] Sample size represents water quality samples having values at or greater than the reporting limit.

Time series data indicate that EC concentrations at the examined stations generally fluctuate on an annual basis (Figure 8-13 and Figure 8-14). However, peak values occurred at different times of the year for the various locations. Factors influencing this variability may include hydrology, water operations, watershed sources, and hydrodynamics in the Delta.

Regulatory criteria with respect to salinity are contained in the Bay-Delta WQCP (see Appendix 8A) and vary depending on the water year type (e.g., wet versus dry) and by location. The southern Delta is regulated by seasonal objectives for the protection of agricultural supply (applicable to all water year types) and consists of a 30-day running average EC of 700 µmhos/cm from April through August, which corresponds to the irrigation season, and 1,000 µmhos/cm for September through March. The interior and western Delta are regulated with seasonal EC objectives ranging from 450 to 2,780 µmhos/cm on a 14-day averaging period, which vary by location and water year type. Higher EC levels are allowable later in the summer as Delta inflows decrease and seawater intrusion is more prevalent. There is a Section 303(d) listing for the western, southern, northwestern, and export areas of the Delta regarding EC. A salinity and boron TMDL for the lower San Joaquin River system has been adopted by the Central Valley Water Board and approved by the USEPA that outlines the program of actions necessary to meet the seasonal 700/1000 µmhos/cm Bay-Delta WQCP objectives for agricultural protection at the Vernalis station. A salinity TMDL addressing the Lower San Joaquin River upstream of Vernalis is in progress. The Central Valley Water Board has also been directed by the State Water Board to develop new salinity water quality objectives for the Lower San Joaquin River upstream of Vernalis. The San Francisco Bay Regional Water Board Basin

Plan has 0.2–3.0 millisiemens per centimeter (200–3,000 µmhos/cm) criteria for agricultural supply-irrigation. No violations occurred at stations in areas where irrigation has taken place. The California drinking water secondary MCL for EC is 0.9 millisiemens per centimeter (900 µmhos/cm). This standard has been exceeded at the Contra Costa Pump #1 on several occasions, and on rare occasions at the Delta-Mendota Canal headworks (Figure 8-13). Salinity objectives applicable to the southern Delta are occasionally exceeded.

8.1.3.2 Bromide and Chloride

Background

Bromide and chloride are specific negatively charged ions (anions) that contribute to salinity and have the potential to most directly affect municipal and domestic supply, agricultural supply, and industrial service supply beneficial uses (Table 8-1). Bromide and chloride are naturally occurring anions whose primary origin is seawater and, thus, are discussed together here. Chloride is typically low in freshwater (i.e., up to tens of mg/L), unless influenced by drainage or groundwater from prehistoric marine landscapes, whereas typical seawater choride concentration is about 19,000 mg/L (Hem 1985). Typical drinking water source concentrations of bromide in the United States average 0.062 mg/L (Amy et al. 1998); typical seawater concentrations of bromide are 67 mg/L (Hem 1985). In addition to its contribution to salinity, bromide is of concern in water as a precursor to the formation of bromate, bromoform and other brominated THMs, and HAAs, which are potentially harmful DBPs in municipal water supplies (CALFED Bay-Delta Program 2003). These compounds have been shown to cause carcinogenic, negative developmental, and negative reproductive effects in laboratory animals (USEPAWebsite 2010).

DBP formation is increased when the source water contains both dissolved organic compounds and halides (CALFED Bay-Delta Program 2007a). Bromate forms when water that contains bromide is disinfected with ozone, a technique employed by many drinking water treatment plants as an alternative to chlorination to reduce DBP formation (in compliance with THM Rule, DBP Stage 1 and Stage 2 Rules).

Importance in the Project Area

The primary source of bromide in the Delta is seawater intrusion from the west (CALFED Bay-Delta Program 2000). As discussed in the salinity subsection with respect to salinity, bromide in the Delta is the result of a complex interplay between hydrology (i.e., dilution), water operations, bromide sources, and hydrodynamics. Because there are several major water diversions in the Delta for municipal water supplies, bromide in the source water is of concern because of the potential for DBP formation.

The magnitude of the problem in the Delta can be seen by examining the range of bromide concentrations during 2003 to 2007 at several locations (PPIC 2008).

- Contra Costa Canal (Rock Slough Intake): 0.008–0.790 mg/L.
- South Delta Pumps (Harvey O. Banks headworks): 0.050–0.410 mg/L.
- North Bay Aqueduct (Barker Slough Pump): <0.090 mg/L.
- Sacramento River at Hood: <0.020 mg/L.
- San Joaquin River near Vernalis: <0.480 mg/L.

Median concentrations at the southern Delta export pumps are about 16 times higher than in the Sacramento River at Hood, and other tributaries upstream of any seawater influence (CALFED Bay-Delta Program 2007a). Relatively high bromide concentrations in the San Joaquin River are attributable to recirculation of Delta salts and bromide through the San Joaquin Valley. Bromide concentration in water diverted from the southern Delta can be estimated from EC or chloride data, with chloride being the most reliable indicator (PPIC 2008). For example, at the Harvey O. Banks headworks (1990–2006), bromide = 0.0033*chloride, r^2 = 0.9547 (CALFED Bay-Delta Program 2007a).

As a major constituent that affects water quality in the Delta, the salinity discussion above fully addresses the importance of chloride. Empirical data demonstrate that EC and chloride concentration are strongly correlated to each other by the equation: EC (µS/cm) = 3.5308*chloride + 192.34, r^2 = 0.999 (adapted from Table 1, Contra Costa Water District 2007).

Existing Conditions in the Project Area

Locations in the northern Delta have had low concentrations of bromide in recent years (water years 2001–2006), with mean values of 0.02 and 0.04 mg/L at the Sacramento River at Hood and Barker Slough Pump locations, respectively (Figure 8-15). Higher mean concentrations are typically seen in the southern Delta, with values of 0.18 mg/L at the Harvey O. Bank pumps, 0.27 mg/L at the San Joaquin River near Vernalis, and 0.28 mg/L at the Contra Costa Pump #1. The highest mean value examined was 5.18 mg/L at the Sacramento River at Mallard Island.

Time series data indicate that bromide concentrations at the examined stations generally fluctuate on an annual basis (Figure 8-16), but depends on location. For example, higher values have tended to occur during the months of March through May at the Barker Slough Pumps, while higher values occurred during the October to early January period atthe Contra Costa Pump #1. Bromide data for the north and south of Delta stations were sparse; values were available for the American River at WTP and were all reported as 0.01 mg/L.

There are presently no regulatory water quality objectives for bromide in the Delta. The state drinking water primary MCL for bromate is 0.01 mg/L. To reduce the potential for DBP formation in municipal water supplies, the CALFED Drinking Water Quality Program has the goal of achieving either a bromide concentration of 0.05 mg/L at the southern and western Delta water export locations, along with an average TOC concentration of 3 mg/L (CALFED Bay-Delta Program 2003), or an "Equivalent Level of Public Health Protection" for municipal water supply purveyors. In general, bromide concentrations are frequently above 0.05 mg/L at Delta locations influential to the water quality of surface water supply purveyors.

Locations in the northern Delta have had low concentrations of chloride in recent years (water years 2001–2006), with mean values of 6 and 22 mg/L at the Sacramento River at Hood and Barker Slough Pump locations, respectively (Figure 8-17). Higher mean concentrations are typically seen in the southern Delta, with values ranging from 59 mg/L at the Harvey O. Bank pumps to 90 mg/L at both the Contra Costa Pump #1 and Franks Tract. Chloride mean concentrations increased at the mouths of the Sacramento River and the San Joaquin River, with the highest value of 6,380 mg/L at Suisun Bay at Bulls Head near Martinez.

Chloride mean concentrations in the north of Delta locations were very low (water years2001–2006), ranging from 1 to 5 mg/L (Table 8-8). South of Delta locations had mean values of 69 mg/L, which were higher than that reported at the Harvey O. Banks headworks (59 mg/L, Figure 8-17).

Table 8-8. Chloride Concentrations at Selected North of Delta and South of Delta Stations, Water Years 2001–2006[a]

	Chloride (dissolved, mg/L)				
Location	Samples	Minimum	Maximum	Mean	Median
Sacramento River at Keswick	46	1	6	2	2
Sacramento River at Verona	21	2	15	5	4
Feather River at Oroville	29	1	3	1	1
American River at WTP	69	1	3	2	2
California Aqueduct at Check 13	69	23	138	69	64
California Aqueduct at Check 29	81	16	127	69	66

Source: California Department of Water Resources 2009b.

[a] Sample size represents water quality samples having values at or greater than the reporting limit.

Notes: mg/L = milligrams per liter; WTP = water treatment plant.

Time series data for chloride displayed annual fluctuations (Figure 8-18 and Figure 8-19), with peaks typically occurring in fall/winter.

The chloride objectives in the Bay-Delta WQCP include a maximum value of 250 mg/L assessed at five municipal supply intakes for compliance. Additionally, a 150 mg/L chloride objective must be met for a certain number of days at the Contra Costa Canal and the San Joaquin River at the Antioch Water Works Intake, and the number of days depends on the water year type. The San Francisco Bay Regional Water Board Basin Plan has a 355 mg/L chloride objective for agricultural supply. CCWD has an objective of delivering treated water that has less than 65 mg/L chloride. No violations occurred at stations in areas where irrigation has taken place. The state drinking water secondary MCL for chloride is 250 mg/L. This standard has been exceeded at the Contra Costa Pump #1 on several occasions and, on rare occasions, at the Delta-Mendota Canal headworks (Figure 8-11).

8.1.3.3 Organic Carbon

Background

Organic carbon consists of degraded plant and animal materials and occurs naturally in the environment, and from anthropogenic sources such as domestic wastewater and urban runoff. TOC represents the summation of both particulate organic carbon and dissolved organic carbon (DOC). Evidence has shown that most of the organic carbon in Delta waters is in the form of DOC (CALFED Bay-Delta Program 2008a).

Organic carbon is a critical part of the food web and sustains aquatic life in the Delta and Bay. However, organic carbon and bromide, a naturally occurring salt found throughout the Delta are precursors that contribute to DBP formation risk at drinking water treatment plants that use disinfection processes to treat Delta surface water sources. DBPs in municipal water supplies can be harmful to humans when consumed at low levels over a lifetime and, thus, organic carbon concentrations are of primary concern for the municipal water supply beneficial use (Table 8-1). DBPs such as THMs and HAAs are known to cause liver, kidney, and central nervous system problems and an increased risk of cancer (U.S. Environmental Protection Agency 2008a). The risk of DBP formation at drinking water treatment plants that use Delta surface water sources has been, and will continue to be a central focus of water quality regulations for the Delta and the SWP/CVP Export Service Area.

DBP-Formation Potential

The primary disinfectants currently used to remove microbial contaminants in municipal drinking water treatment plants consist of chlorine, chloramines, ozone, and ultraviolet (UV) light . Numerous DBPs can be formed by disinfectants reacting with various constituents in the source water, particularly DOC, bromide, and nitrogenous compounds Chlorine-based disinfectents are a cause in the formation of many DBPs including the THMs i.e., chloroform, bromodichloromethane, dibromochloromethane, and bromoform) and HAAs (i.e., monochloroacetic acid, dichloroacetic acid, trichloroacetic acid, monobromoacetic acid, and dibromoacetic acid). Modern disinfection methods used instead of chlorine to reduce DBP formation include chloramines and chlorine dioxide, ozone, and UV light. Ozone can substantially reduce THM formation and UV light doesn't form DBPs; however, ozone can cause formation of bromate if bromide is present in the water (see the *Bromide* section for a detailed discussion of its effects on water quality). UV light disinfection system design must account for potential reduced efficiency associated with elevated turbidity and suspended solids (which can shield bacteria/viruses from radiation) and biological fouling of lamps, Ozone and UV light disinfection processes leave no residual disinfectant in the treated water, so a chlorine disinfectant generally must be added to finished water to provide a residual level of disinfection effect from the drinking water treatment plant through the distribution system to a user's tap. The potential for DBPs to form during drinking water disinfection is a function of source water quality, primarily influenced by DOC concentration and bromide, and a function of treatment operational factors such as disinfectant dose and reaction time, pH, and temperature (Sadiq and Rodriquez 2004). The potential formation of THMs, HAAs, and bromate has been extensively studied and models are able to predict their formation with reasonable accuracy (Sohn et al. 2004).

Methods to Reduce DBP Formation Risk

Identifying and developing dynamic strategies and options to reduce DBP formation requires analysis of technical feasibility and economic considerations, and is one element of the Equivalent Level of Public Health Protection (ELPH) concept of a multibarrier approach to providing drinking water and public health protection. Because organic/inorganic substances act as precursors for DBPs, their removal prior to disinfection is effective in reducing DBP formation potential. Organic matter can be partially removed using conventional coagulation, flocculation, sedimentation, and filtration methods or with more advanced methods (e.g., enhanced coagulation, granular activated carbon [GAC] filtration, and membrane filtration). The control of water treatment operational factors such as pH or disinfection contact time may reduce the formation of DBPs. Ozonation and UV light are the primary existing and alternative disinfection processes to reduce DBP formation that have been considered or implemented by water purveyors that use Delta source waters (Chen et al. 2010). pH reduction can control bromate formation during ozonation; however, the process requires increased ozone dosage, and large amounts of acid to lower the pH and base addition to raise pH after ozonation to prevent corrosion in the distribution system (TetraTech 2006a).

Importance in the Project Area

Our understanding of organic carbon dynamics in the Delta has greatly advanced in recent years, due in part to intensive sampling efforts as well as research conducted by various institutions (e.g., Chow et al. 2007; Deverel et al. 2007; Drexler et al. 2009a, 2009b; Eckard et al. 2007; Kratzer et al.

2004; Kraus et al. 2008; Saleh et al. 2007; Sickman et al. 2007; Spencer et al. 2007; Stephanauskas et al. 2005; U.S. Geological Survey 2003). Sources of organic carbon in the project area include peat soils, agricultural and urban runoff, wetlands, and wastewaters. Rivers supply the bulk of organic carbon loading to the Delta; however, the contribution varies seasonally from approximately 50% to up to 90% of the TOC load (CALFED Bay-Delta Program 2008a). Table 8-9 provides a summary of organic carbon concentrations at several Delta intakes and major tributaries. In general, the highest average concentrations of organic carbon originate from the San Joaquin River and in the Delta, while the lowest average concentrations originate from the Sacramento River. On an annual basis, the Delta contributes about 25% of the organic carbon exported, and the remainder is contributed by rivers and upstream sources (CALFED Bay-Delta Program 2008a). Peak concentrations are important to municipal drinking water treatment purveyors due to regulations that require advanced treatment depending on DOC levels. Drinking water treatment plants using North Bay Aqueduct water have repeatedly shut down, switched to blending operations with better quality water, or alternative water sources to avoid periodic flooding-induced spikes in DOC (MWQI 2002).

Table 8-9. Total Organic Carbon Concentrations at Delta Intakes and Major Tributaries

Intake	Form	Period	Number of Samples (n)	Median TOC (mg/L)	Maximum TOC (mg/L)
Harvey O. Banks	TOC	1986–2006	252	3.20	16.3
C. W. Jones (Tracy)	TOC	1986–1999	29	3.30	5.0
CCWD Old River	TOC	1994–2006	176	3.00	14.0
CCC (Rock Slough)	TOC	1991–2006	169	3.60	40.0
North Bay Aqueduct (Barker Slough)	TOC	1988–2006	289	4.70	38.0
Sacramento River	TOC	1998–2006	595	1.75	8.6 (19.9)[a]
San Joaquin River at Vernalis	TOC	1986–2006	418	3.30	10.5

Source: CALFED Bay-Delta Program 2007b.
Notes:
CCC = Contra Costa Canal
CCWD = Contra Costa Water District
NBA = North Bay Aqueduct
mg/L = milligrams per liter
TOC = total organic carbon
[a] Maximum reported value is 19.9 mg/L, second highest is 8.6 mg/L; site: Hood/Greene's Landing.

Existing Conditions in the Project Area

Examined locations in the Delta with the lowest observed mean concentrations of DOC during the waters years 2001–2006 ranged from 1.9 to 2.2 mg/L, with the lowest concentrations occurring in the Sacramento River at Hood (Figure 8-20). Higher mean concentrations of DOC occurred in the southern Delta, ranging from 3.3 mg/L at the Harvey O. Banks headworks location to 3.8 mg/L at the San Joaquin River near Vernalis. The highest observed mean DOC concentration occurred at the Barker Slough Pump (5.7 mg/L), which is indicative of organic load flux from the Yolo Bypass which is known to have high mean concentrations and relative loading (Tetra Tech 2006a). However, the Yolo Bypass loading is intermittent, only occurring in large amounts in the generally wetter hydrologic year types when the Yolo Bypass is used for conveyance of high flows.

Mean values for the north of Delta area ranged from 1.5 mg/L at the Feather River at Oroville to 2.0 mg/L at the Sacramento River at Veteran's Bridge (Table 8-10). South of Delta mean values were higher than north of Delta stations examined (3.2 to 3.4 mg/L), and comparable to the mean at the Harvey O. Banks headworks (3.3 mg/L, Figure 8-20).

Table 8-10. Dissolved Organic Carbon Concentrations at Selected North and South of Delta Stations, Water Years 2001–2006[a]

	Dissolved Organic Carbon (mg/L as C)				
Location	Samples	Minimum	Maximum	Mean	Median
Sacramento River at Keswick	10	0.9	2.5	1.6	1.5
Sacramento River at Veteran's Bridge	18	1.2	4.3	2.0	1.6
Feather River at Oroville	28	1.0	2.2	1.5	1.5
American River at WTP	156	1.1	3.7	1.6	1.5
California Aqueduct at Check 13	115	2.1	8.0	3.4	3.1
California Aqueduct at Check 29	86	1.8	7.4	3.2	3.0

Sources: California Department of Water Resources 2009b; Sacramento Regional County Sanitation District 2004, 2005, 2006, 2007, 2008, 2009.

Notes: mg/L = milligrams per liter; WTP = water treatment plant

[a] Sample size represents water quality samples having values at or greater than the reporting limit.

Time series data indicate that DOC concentrations at the examined stations generally fluctuate on an annual basis (Figure 8-21 and Figure 8-22). Higher values have tended to occur during the months of December through March at most locations, particularly the Sacramento River and in-Delta locations, whereas the San Joaquin River concentrations tend to be higher in the summer months as a result of irrigated agricultural drainage (Tetra Tech 2006a).

Examined locations in the Delta with the lowest observed mean concentrations of TOC during the water years 2001–2006 ranged from 2.7 to 3.0 mg/L, occurring at the Sacramento River at Hood and in the Delta export region (Figure 8-23). Higher mean concentrations of TOC occurred in the southern Delta region, ranging from 3.8 mg/L at the Contra Costa Pump #1 location to 5.1 mg/L at the San Joaquin River near Vernalis. The highest observed mean TOC concentration occurred at the Barker Slough Pump (7.8 mg/L).

Mean values for the north of Delta area ranged from 1.5 mg/L at the Sacramento River at Keswick to 2.1 mg/L at the Sacramento River at Veteran's Bridge (Table 8-11). South of Delta mean values were higher than north of Delta stations examined (3.9 to 4.2 mg/L), and slightly lower than the mean at the Harvey O. Banks headworks (4.3 mg/L, Figure 8-23).

Table 8-11. Total Organic Carbon Concentrations at Selected North and South of Delta Stations, Water Years 2001–2006[a]

	Total Organic Carbon (mg/L as C)				
Location	Samples	Minimum	Maximum	Mean	Median
Sacramento River at Keswick	15	1.0	2.6	1.5	1.4
Sacramento River at Veteran's Bridge	18	1.2	5.9	2.1	1.6
Feather River at Oroville	28	1.4	3.6	2.0	1.9
American River at WTP	162	1.2	4.8	1.8	1.6
California Aqueduct at Check 13	203	2.1	12.6	4.2	3.5
California Aqueduct at Check 29	158	1.9	14.5	3.9	3.5

Sources: California Department of Water Resources 2009b; Sacramento Regional County Sanitation District 2004, 2005, 2006, 2007, 2008, 2009.

Notes: mg/L = milligrams per liter; WTP = water treatment plant

[a] Sample size represents water quality samples having values at or greater than the reporting limit.

Time series data indicate that TOC concentrations at the examined stations generally fluctuate on an annual basis (Figure 8-24 and Figure 8-25). Higher values have tended to occur during the months of December through March.

Regulatory criteria regarding organic carbon are as follows. Organic carbon is on the 2010 Section 303(d) list with respect to organic enrichment in the Stockton Deep Water Ship Channel. There are no TOC or DOC criteria/objectives in the CTR, the Central Valley Water Board Basin Plan, the San Francisco Bay Regional Water Board Basin Plan, nor are there any California drinking water MCLs for organic carbon. However, under the Stage 1 Disinfectants and Disinfection Byproducts Rule under the Safe Drinking Water Act, TOC is an important parameter for water purveyors that produce potable drinking water from surface water sources. The rules require the removal of specific percentages of TOC in the source water through treatment methods (unless the system can meet alternative criteria). CALFED established a TOC goal of 3 mg/L, along with a bromide goal of 50 µg/L, for the southern and central Delta drinking water intake locations to prevent additional risks of DBP formation. Optional to the TOC and bromide goals, the CALFED goal is to provide an ELPH, which is a concept of a multi-barrier approach to reducing DBP risks through alternative strategies such as alternative water supplies or blending, drinking water treatment strategies, or other measures.

DBP Formation Potential

In the Delta, THM formation has been found to be strongly correlated to TOC concentrations, but relationships to DOC depend on specific structural characteristics of the organic matter and research has focused on the sources of DOC as being a critical factor for THM formation potential (TetraTech 2006a). The measurement of specific UV light absorbance at a wavelength of 254 nm (SUVA) is a commonly used measure of the potential conversion of DOC compounds into aromatic compounds such as THMs; however, SUVA has been found to be a generally poor predictor of THM formation potential in Delta waters (TetraTech 2006a). DWR's Municipal Water Quality Investigations (MWQI) program found that HAA formation potential also is strongly correlated to DOC concentrations (MWQI 2003). THMs are generally anticipated to be the most abundant DBP formed in treated Delta source water, with HAA formation generally expected to be less than 50% of the THM production.

The EPA promulgated the Stage 1 Disinfectants and Disinfection Byproducts (D/DBP) Rule in 1998 and the Stage 2 D/DBP Rule in 2006 under the Safe Drinking Water Act (SDWA) which collectively establish the treatment standards for DBPs, tightened compliance monitoring requirements for DBPs, and strengthened public health protection related to DBP exposure in municipal water distribution systems. The Long Term 2 Enhanced Surface Water Treatment Rule focuses on reducing illness from cryptosporidium and other disease-causing microorganisms in drinking water distribution systems, and requires water utilities to balance long-term and short-term health concerns posed by DBPs and pathogens, respectively. The compliance challenge for water treatment plant operators is to provide adequate disinfection to protect against pathogens without forming DBPs. Development of the Delta Drinking Water Policy by the Central Valley Water Board was identified as a future need during the 1998 and 2001 triennial reviews of the Basin Plan, and by the CALFED process, with a goal of completing the policy and associated Basin Plan amendments in 2013.

8.1.3.4 Water Temperature

Background

The temperature of water affects the physical, chemical, and biological environment. Warmer summer water temperatures are typically the result of warmer air temperatures; this is the time of year when water loss attributable to evaporation is greatest.

One of the outcomes of evaporation can be an increase in water quality constituent concentrations. This is of concern with respect to potentially harmful constituents such as pesticides, heavy metals, and others, since toxicity to aquatic organisms (e.g., fish) typically increases with the concentration of these toxins in water. Increasing water temperature also tends to increase chemical reaction rates, which can increase chemical stresses on aquatic organisms.

The beneficial uses in the project area affected by water temperature include shellfish harvesting; commercial and sport fishing; warm freshwater habitat; cold freshwater habitat; migration of aquatic organisms and spawning, reproduction, and/or early development; and estuarine habitat (Table 8-1) because there are relatively low thermal thresholds for coldwater fish species, such as Chinook salmon and steelhead. Water temperature can affect DO concentrations; as water temperature increases, DO concentrations can decrease (see next section for a detailed discussion of DO). Agricultural rice production also is sensitive to cold water temperatures that can suppress seed germination, and is of particular concern for SWP's operational releases from Lake Oroville / Thermalito Afterbay in the lower Feather River basin. Generally, the same beneficial uses and receptors most susceptible to reduced DO concentrations are also affected by increased temperature conditions. Both high water temperature and low DO concentrations can negatively affect aquatic life, making fish more susceptible to contaminants and disease, and can serve as a barrier to migration (see Chapter 11, *Fish and Aquatic Resources*, for a detailed discussion of the effects of temperature on Delta fish species).

Increasing water temperature also tends to increase aquatic plant and animal metabolism (growth, respiration). When the growth rates of algae increase, there are multiple implications for drinking water quality. Increased algal growth can increase the quantity of organic carbon in water, thereby leading to increased formation of DBPs (see previous section for detailed discussions of organic carbon and DBPs) in treated drinking water. These algae can also clog filters and other equipment used for water treatment, and some species can produce harmful toxins.

Werner et al. (2008) suggest that water temperature is perhaps the most important factor affecting the biochemical and physiological processes of individual aquatic organisms, by affecting contaminant transformation and excretion rates. While temperature increases cause an increase in the bioaccumulation and toxicity of metals and organophosphate pesticides (Newman and Unger 2003), temperature increases decrease pyrethroid pesticide toxicity because of enhanced compound degradation (Werner and Oram 2008).

River water temperature can be affected by upstream reservoir releases in warmer weather, when deep waters are colder than surface waters in reservoirs. Conversely, shallow impoundments, or sloughs of the Delta, that increase the surface area and reduce the velocity of water flow, thereby increasing the hydraulic residence time of the flow, can result in more heat gain than a faster flowing river. Shading of water surfaces by riparian vegetation tends to reduce the amount of heat gain compared to open and exposed water bodies.

Within the Sacramento River basin, water temperature is influenced by: (1) the relative water temperatures of releases from Shasta Dam and Trinity River water conveyed through the Whiskeytown Reservoir; (2) depths from which releases are made; (3) seasonal management of the deep cold water reserves; (4) ambient seasonal air temperatures and other climatic conditions; and (5) residence time in Keswick Reservoir. Many of the temperature management decisions for the major reservoirs located on Central Valley rivers are directed through the operating permits and licenses of the State Water Board, as dictated by federal agencies (National Marine Fisheries Service [NMFS], USEPA) and state agencies (California Department of Fish and Game [DFG], Regional Water Boards). Temperature regulations are often determined via biological opinions issued by the resource agencies in association with Endangered Species Act (ESA) consultation processes. Reclamation installed a temperature control device on the power penstocks at Shasta Dam in 1997 to enable selective release of water from varying lake levels through the power plant in order to manage available coldwater pool resources and maintain adequate water temperatures in the Sacramento River downstream of Keswick Dam. Farther downstream, the seasonal installation of the Red Bluff Diversion Dam and larger tributary accretions affect lower Sacramento River temperature patterns. Reclamation makes temperature management decisions for the Sacramento River based on annual plans developed through a multistakeholder Sacramento River Temperature Task Group to balance coldwater resources and habitat needs for different species in spring, summer, and fall, and within the constraints of interrelated project operations and water demands. Temperatures in the lower Feather River and Lower American River are similarly managed by SWP and CVP, respectively, to balance available coldwater resources for requirements of salmon in the late fall and meet other temperature targets throughout the year.

Other sources of heat include discharges from industrial and municipal activities, such as discharges from facilities that use large quantities of water for cooling purposes (e.g., power generating plants). These can return water to a river that is several degrees warmer than the river temperature. Finally, stormwater runoff can be heated by impervious surfaces such as parking lots, which can drain to local water bodies.

Importance in the Project Area

As described above, water temperature can influence the effects of a variety of other water quality constituents. Changes in Delta water temperature may affect certain water quality constituents such that aquatic life is negatively affected. Local increases in water temperature in the Delta are most likely caused by agricultural and stormwater runoff, industrial and municipal waste streams, and by warm inflows from the San Joaquin River. Increases in water temperature can affect aquatic organisms in the Delta such as fish and, in particular, the Delta is a primary migration corridor for anadromous fish species that require specific temperature regimes for successful completion of their life cycle (see Chapter 11, *Fish and Aquatic Resources*, for a detailed discussion of the effects of temperature on fish species that inhabit the project area.) [*Note to Lead Agencies: This section in Chapter 11 is in preparation*].

Existing Conditions in the Project Area

Mean temperature values for the water years 2001–2006 were similar between the examined sites in the Plan Area, ranging from 16.3 to 18.9°C (Figure 8-26). The mean water temperature at the Sacramento River at Hood was 17.0°C, compared to 18.0°C at the San Joaquin River near Vernalis. Water temperatures at interior Delta locations averaged 18.1°C (Franks Tract near Russo's Landing; Old River at Rancho del Rio).

Mean values for the north of Delta area were near 11.0°C at the Sacramento River at Keswick and the Feather River at Oroville, with mean values near 14.5°C near the Sacramento metropolitan area (Table 8-12). South of Delta mean values were higher than north of Delta and Plan Area stations examined, reflecting the north–south California Central Valley gradient of temperature values.

Table 8-12. Water Temperature at Selected North and South of Delta Stations, Water Years 2001–2006[a]

	Water Temperature (°C)				
Location	Samples	Minimum	Maximum	Mean	Median
Sacramento River at Keswick	32	8.2	13.4	10.8	10.5
Sacramento River at Verona	12	9.4	21.3	14.6	13.5
Feather River at Oroville	29	7.4	15.4	11.0	10.5
American River at WTP	120	8.8	24.3	14.4	13.6
California Aqueduct at Check 13	69	8.6	23.7	16.5	16.5
California Aqueduct at Check 29	73	10.0	28.5	18.6	19.0

Source: California Department of Water Resources 2009b.
Notes: C = Celsius; WTP = water treatment plant
[a] Sample size represents water quality samples having values at or greater than the reporting limit.

Time series data indicate that water temperature values at the examined stations generally fluctuate on an annual basis (Figure 8-27 and Figure 8-28), with higher values occurring during the months of June through September and lower values during the months of December through March.

Regulatory criteria with respect to temperature are as follows. The Central Valley Water Board and San Francisco Bay Regional Water Board Basin Plans contain a numerical objective that limits the allowable temperature increase from controllable factors to less than 5°F. The *Water Quality Control Plan for the Control of Temperature in the Coastal and Interstate Waters and Enclosed Bays and Estuaries of California* (Thermal Plan) sets limits for *thermal waste* and *elevated temperature waste* discharged into coastal waters, interstate waters, and enclosed bays and estuaries of California (State Water Resources Control Board1975). Objective 5A(1)a of the Thermal Plan prohibits an elevated temperature waste discharge to estuaries that exceeds the natural receiving water temperature by more than 20°F (State Water Resources Control Board 1975). Objective 5A(1)b prohibits a waste discharge that would cause more than a 1°F rise in more than 25% of the receiving water cross-section at the discharge location. Objective 5A(1)c states that no discharge shall cause a surface water temperature rise of more than 4°F above the natural receiving water temperature at any time. The Thermal Plan further states that for estuaries, the maximum temperature of thermal waste discharges shall not exceed 86°F, and that the maximum temperature shall not be more than 4°F above the natural temperature of the receiving water. There are no Section 303(d) listings for water temperature for the Delta. There also are no temperature criteria in the CTR, nor are there any California drinking water MCLs for temperature.

8.1.3.5 Dissolved Oxygen

Background

DO is a measure of the concentration of oxygen carried in a water body. Water gains oxygenfrom the atmosphere and from aquatic plant photosynthesis. DO in water is consumed through respiration by aquatic animals, decomposition of plant and animal material (microbial respiration), sediment oxygen demand, and various chemical processes. DO depletion primarily affects aquatic life beneficial uses, which include warm freshwater habitat; cold freshwater habitat; migration of aquatic organisms and spawning, reproduction, and/or early development; estuarine habitat; and rare, threatened, or endangered species (Table 8-1). The most sensitive receptors include cold freshwater habitat and migration of aquatic organisms and spawning, reproduction, and/or early development due to the relatively high DO requirements of coldwater fish, such as Chinook salmon and steelhead. Low DO concentrations in water bodies can have adverse effects on aquatic life, including fish kills, fish egg mortality, and growth rate reductions, and can serve as a barrier to migration of anadromous fish such as Chinook salmon (California Environmental Protection Agency 2006; Schmieder et al. 2008).

Seasonal declines in DO are typical in many estuaries, and DO concentrations are negatively affected by increases in water temperature (Schmieder et al. 2008). Nutrient loading from point and nonpoint sources can result in increased algal growth, thereby lowering DO concentrations in water bodies (Schmieder et al. 2008) (see discussion later in this section for details of nutrient loading in the Delta). Activities that disturb sediments and aquatic plants such as dredging and clearing of aquatic plants from ship channels can cause increased decomposition of organic material, resulting in decreases in DO concentrations (Greenfield et al. 2007; Schmieder et al. 2008). However, removal of aquatic plants, especially invasive plant species, may allow light to better penetrate the water column, increasing photosynthesis and thereby increasing DO concentrations (Greenfield et al. 2007).

Importance in the Project Area

Although localized incidents of depressed DO concentrations may occur in the project area, it can be argued that the primary concern occurs in the Stockton Deep Water Ship Channel. The San Joaquin River experiences regular periods of low DO concentrations in the Stockton Deep Water Ship Channel from the City of Stockton downstream to Disappointment Slough (Figure 8-5). These conditions often violate the Basin Plan water quality objective for DO in the Stockton Deep Water Ship Channel; they occur most often during the months of June through October, although severe conditions have occurred in the winter months as well (California Environmental Protection Agency 2006; Schmieder et al. 2008). Data also show that the frequency and severity of low DO concentrations are generally worse during dryer water years (Table 8-13) (California Environmental Protection Agency 2006).

Table 8-13. Temporal Distribution of Low Dissolved Oxygen Impairment

Year		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1983	Excursion rate (%)[a]	n/a	n/a	n/a	n/a								
	Minimum (DO)[b]												
1984	Excursion rate (%)[a]				1	7	84	91	62	2			
	Minimum (DO)[b]				*4.4*	*3.9*	*3.0*	*2.8*	*4.0*	*4.7*			
1985	Excursion rate (%)[a]				6		48	78	15				
	Minimum (DO)[b]				*4.4*		*3.3*	*3.5*	*4.2*				
1986	Excursion rate (%)[a]	29				5		21	9				
	Minimum (DO)[b]	*4.4*				*3.1*		*4.5*	*4.8*				
1987	Excursion rate (%)[a]					44	43	3		29		<1	
	Minimum (DO)[b]					*3.5*	*3.6*	*4.6*		*3.9*		*4.9*	
1988	Excursion rate (%)[a]	51	52	52			3		10	62			
	Minimum (DO)[b]	*3.5*	*3.3*	*3.8*			*4.8*		*4.4*	*2.3*			
1989	Excursion rate (%)[a]			65	<1		37	2		38	14		
	Minimum (DO)[b]			*3.7*	*4.9*		*4.1*	*4.8*		*2.4*	*4.2*		
1990	Excursion rate (%)[a]			1	5	3	11	<1	<1				
	Minimum (DO)[b]			*4.8*	*4.6*	*4.7*	*4.5*	*4.8*	*4.9*				
1991	Excursion rate (%)[a]		<1	8	37	34	1	5	14	55	99		
	Minimum (DO)[b]		*4.7*	*4.3*	*4.4*	*4.2*	*4.9*	*4.7*	*4.4*	*1.8*	*0.4*		
1992	Excursion rate (%)[a]		21	100	60	29	43	39	97	100	77	6	
	Minimum (DO)[b]		*3.1*	*2.1*	*1.9*	*3.6*	*3.7*	*3.7*	*2.8*	*0.5*	*1.3*	*4.7*	
1993	Excursion rate (%)[a]			25	8	2	29	54	87	81	23		1
	Minimum (DO)[b]			*3.7*	*4.7*	*4.8*	*3.6*	*3.7*	*2.6*	*2.6*	*1.6*		*4.8*
1994	Excursion rate (%)[a]		2		<1		61	80	63	16	46		
	Minimum (DO)[b]		*4.8*		*4.9*		*4.0*	*3.7*	*3.4*	*4.3*	*3.2*		
1995	Excursion rate (%)[a]							2	61	6			
	Minimum (DO)[b]							*4.8*	*3.0*	*4.6*			
1996	Excursion rate (%)[a]	15	n/a				8	63	94	89	15	18	
	Minimum (DO)[b]	*4.1*					*4.8*	*3.4*	*2.0*	*2.5*	*3.7*	*4.3*	
1997	Excursion rate (%)[a]						14	74	88	83	44	2	11
	Minimum (DO)[b]						*3.6*	*3.1*	*3.3*	*2.4*	*2.2*	*4.7*	*4.5*
1998	Excursion rate (%)[a]												
	Minimum (DO)[b]												
1999	Excursion rate (%)[a]					n/a	<1	48	20	43	100	93	39
	Minimum (DO)[b]						*4.9*	*3.0*	*3.1*	*1.8*	*1.7*	*3.8*	*3.8*
2000	Excursion rate (%)[a]	4	11				11	61	28	1			12
	Minimum (DO)[b]	*4.7*	*3.9*				*2.9*	*2.9*	*2.7*	*4.8*			*4.7*

Year		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2001	Excursion rate (%)[a]	5					69	75	73	61			n/a
	Minimum (DO)[b]	*4.7*					*2.5*	*2.3*	*3.0*	*2.9*			
Avg[c]		5	6	14	6	6	27	34	37	36	23	3	4

Source: California Environmental Protection Agency 2006.

Notes: For each month of the year in the table, the upper number presented is the percentage of hourly DO measurements below 5.0 mg/L recorded that month. If a cell is blank, there were no DO measurements below 5.0 mg/L that month. If a cell contains "n/a," no data was recorded at all for that month. The lower italicized number presented for each month is the minimum DO concentration measured that month. The average rate (weighted to account for months with partial data sets) for the 19-year period is shown in the bottom row.

[a] Excursion rate is the number of hourly average DO measurements from the California Department of Water Resources monitoring station below 5.0 mg/L divided by the total number of such measurements recorded that month, shown as a percentage.

[b] The minimum hourly average DO measurement for the month in mg/L.

[c] Average excursion rate is not the simple average of all monthly data—it is weighted to account for months that had only partial data sets.

The Stockton Deep Water Ship Channel is a portion of the San Joaquin River that has been dredged by the U.S. Army Corps of Engineers to a depth of 35 feet to allow for the navigation of cargo vessels between San Francisco Bay and the Port of Stockton (California Environmental Protection Agency 2006). Upstream of the channel, the San Joaquin River is otherwise about 10 feet deep. The entire length of the channel is within the tidal prism and experiences regular flow reversals (California Environmental Protection Agency 2006). Increased water depth increases the time required to aerate the water column and the residence time of water in the channel, and promotes stronger thermal stratification during summer months, which lessens the amount of mixing; these conditions negatively affect DO concentrations in the channel (Schmieder et al. 2008).

The occurrence of low DO concentrations also coincides with periods of low flow conditions, indicating that flow and channel morphology in the San Joaquin River are important factors influencing DO conditions in the Stockton Deep Water Ship Channel.

Table 8-13 demonstrates that the frequency of violations of the 5.0 mg/L objective since 1983 is highest, on the average, during the months of June through October (California Environmental Protection Agency 2006, California Department of Water Resources 2009b). Oxygen concentrations less than 5.0 mg/L, however, have occurred during all months of the year. The frequency of violations is worse in dry years (1991 through 1993), and less frequent during wet years (1998) (California Environmental Protection Agency 2006). An analysis of over 20 years of time series data suggests that the low DO problem is attributable to a combination of river discharge, river phytoplankton, and formerly discharges of elevated ammonia levels from the Stockton wastewater treatment plant, including large seasonal wastewater loading from food canneries (Jassby and Van Nieuwenhuyse 2005).

Existing Conditions in the Project Area

All examined locations in the Delta had mean DO concentrations above 8.4 mg/L in recent years (water years 2001–2006) except the San Joaquin River at Buckley Cove (6.8 mg/L, Figure 8-29). DO minima were above 7.0 mg/L at all examined stations except the Sacramento River at Hood (4.8 mg/L), which was the only value at that location below 6.0 mg/L during that time period, the San

Joaquin River at Vernalis (4.3 mg/L), the Sacramento River at Mallard Island (6.5 mg/L), and the San Joaquin River at Buckley Cove (3.3 mg/L), which falls under the Stockton Deep Water Ship Channel water quality criteria. Mean values for the north of Delta area ranged from 9.6 mg/L at the American River at WTP to 11.0 mg/L at the Sacramento River at Keswick (Table 8-14). South of Delta mean values were lower than north of Delta stations examined (8.2 to 8.9 mg/L).

Table 8-14. Dissolved Oxygen Concentrations at Selected North and South of Delta Stations, Water Years 2001–2006[a]

	Dissolved Oxygen (mg/L)				
Location	Samples	Minimum	Maximum	Mean	Median
Sacramento River at Keswick	32	7.3	15.6	11.0	11.1
Sacramento River at Verona	15	5.4	13.0	10.0	10.0
Feather River at Oroville	29	7.4	12.5	10.1	10.2
American River at WTP	120	6.5	13.0	9.6	9.5
California Aqueduct at Check 13	68	5.7	10.9	8.9	9.0
California Aqueduct at Check 29	49	0.0	12.6	8.2	9.5

Source: California Department of Water Resources 2009b.
Notes: mg/L = milligrams per liter; WTP = water treatment plant
[a] Sample size represents water quality samples having values at or greater than the reporting limit.

Time series data indicate that DO concentrations at the examined stations generally fluctuate on an annual basis (Figure 8-30 and Figure 8-31). Higher values have tended to occur during the months of November through March, with lower values occurring during June through September. The San Joaquin River at Buckley Cove site has continued to experience low DO concentrations, primarily in the late summer to late fall period.

The Central Valley Water Board and San Francisco Bay Regional Water Board Basin Plans contain specific numerical DO objectives that require concentrations to generally be above 7.0 mg/L west of the Antioch Bridge, above 6.0 mg/L in the Stockton Deep Water Ship Channel in October and November, and above 5.0 mg/L at all other locations and times. In January 1998, the State Water Board adopted a CWA Section 303(d) list identifying the DO impairment in this portion of the San Joaquin River/Stockton Deep Water Ship Channel as a high priority (California Environmental Protection Agency 2006). This initiated the need to develop a TMDL as an amendment to the Basin Plan; the TMDL for DO in the channel has been implemented (California Environmental Protection Agency 2006). An objective for DO with respect to fish and wildlife beneficial uses exists in the 2006 Bay-Delta WQCP (Appendix 8A) for the San Joaquin River between Turner Cut and Stockton: 6.0 mg/L between September and November, or else 5.0 mg/L. There are no DO criteria in the CTR, nor is there a California drinking water MCL for DO.

Actions that are being taken to address DO conditions in the Stockton Deep Water Ship Channel, or have assisted in improving DO conditions, include the construction of water aeration devices by the Port of Stockton at the confluence of the San Joaquin River and Stockton Deep Water Ship Channel and by DWR with a new aeration facility at the west end of the Port of Stockton docks in the Deep Water Ship Channel. DWR's aeration facility is much larger than the Port of Stockton system and injects pure oxygen into the Deep Water Ship Channel through a 200-foot long diffuser during periods when DO conditions approach, or drop below, 5 mg/L. Testing of the facility during 2008–

2010 indicates that the aeration facility can help prevent exceedances of the DO objectives, but is not sufficient to prevent low DO under all possible upstream oxygen loading conditions (ICF International 2010). Additionally, the City of Stockton Regional Wastewater Control Facility (RWCF) constructed nitrifying bio-towers that became operational in 2006 which, by converting ammonia to nitrate, reduce the historic ammonia loading rate and its associated oxygen demand to the San Joaquin River by about 90%.

8.1.3.6 Turbidity and Total Suspended Solids

Background

Total suspended solids (TSS) is a measure of the particulate matter that is suspended in the water column. Turbidity is a measure of the optical property of water that causes light to be scattered and absorbed rather than transmitted through the water column. The scattering and absorption of light is caused by: (1) water itself; (2) suspended particulate matter (colloidal to course dispersions); and (3) dissolved chemicals. Hence, suspended solids are but one of the factors affecting turbidity, but often the dominant one. Thus, there is typically, but not always, a good relationship between turbidity and TSS, but this relationship will vary spatially and seasonally. Sensitive receptors that have the potential to be affected by elevated concentrations of turbidity and TSS (Table 8-1) are municipal and industrial water supply uses (municipal and domestic supply/industrial service supply), aquatic life beneficial uses (i.e., warm freshwater habitat, cold freshwater habitat, migration of aquatic organisms and spawning, reproduction, and/or early development), and estuarine habitat because of habitat and other physiological effects.

Turbidity is a critical measurement for drinking water treatment plants because the constituents suspended in the water affect the filtration systems used to remove disease-causing microorganisms such as viruses, parasites, and some bacteria (e.g., fecal coliforms). Turbidity can also reduce the efficiency of disinfection techniques; disinfectants do not selectively target microbes but, rather, react with many constituents within the water matrix (CALFED Bay-Delta Program 2008a).

TSS is a measure of all particulate matter suspended in the water column, consisting of organic materials (e.g., decaying vegetation) as well as inorganic materials (e.g., inorganic components of soil). Monitoring in the San Francisco estuary has used turbidity as a proxy for TSS, which in turn has been correlated to contaminant concentrations such as metals, polycyclic aromatic hydrocarbons (PAHs), and organochlorine pesticides (Schoellhamer et al. 2007a). One study by Anderson et al. (2007) collected sediment samples between 1994 and 2001 from the mouths of the Sacramento and San Joaquin Rivers; all the samples collected were found to be toxic to mussels. These results suggest that the greatest concern for human health is not TSS itself, but rather the contaminants associated with the solids and sediment, which can bioaccumulate up the aquatic food chain and be consumed by humans (e.g., fish, shellfish).

Elevated levels of turbidity and TSS limit light penetration into the water column, altering photosynthesis, primary production, and fish behavior (Schoellhamer et al. 2007b). After runoff events, TSS can settle to cover streambed spawning sites for fish and also alter macroinvertebrate habitat.

Importance in the Project Area

A major historical source of TSS in central California was hydraulic mining for precious metals in the late 1800s and early 1900s. The majority of this mining sediment has passed through the Delta system, although mine tailings remain in many watersheds. The construction and operation of dams in the Sacramento and San Joaquin River system has the effect of reducing TSS concentrations downstream because sediments become trapped in the reservoirs. Floodplain management in the form of levees can contribute to in-stream erosion by confining the flow to the channel and increasing streambed shear stress (Schoellhamer et al. 2007b). However, the use of bank protection materials likely reduces this effect.

Given that the dam and levee systems in place are unlikely to be removed, the human activity that most likely affects sediment delivery to the Delta is soil erosion associated with agricultural and urban land uses. These activities are pertinent because they occur downstream from the major dams on the system (Schoellhamer et al. 2007b). Examples include crop production, livestock production, and construction activities. Stormwater runoff and overland flow are the likely mechanisms delivering sediment to streams and larger rivers.

Maintenance of the islands and wetlands in the Delta depends on replenishment of their sediments from upstream sources. At the same time, erosion in Delta channels may expose previously contaminated sediments that can negatively affect biota and drinking water supplies. The Delta has also been identified as a source of toxic sediments to the San Francisco estuary (Anderson et al. 2007).

In addition, aquatic species such as the delta smelt tend to prefer turbid waters (CALFED Bay-Delta Program 2008a). Moreover, relatively turbid Delta waters limit light penetration, thereby limiting the frequency and magnitude of nuisance algal blooms.

TSS concentrations in the Delta range from 10 to 50 mg/L, but can exceed 200 mg/L during flood events (Schoellhamer et al. 2007b). The size of suspended particles in Delta waters is typically less than 63 microns. These are silts and clays that tend to remain suspended in the water column (Schoellhamer et al. 2007b). Particulates in the water column play an important role in chemical adsorption and the transport of pollutants. The most sediment is supplied to the Delta during high flows (Wright and Schoellhamer 2005; McKee et al. 2006).

The average annual Delta sediment budget for 1999–2002 as presented by Schoellhamer et al. (2007b) is shown in Figure 8-32. The Sacramento River supplies the greatest input of sediment (66%), followed by the Yolo Bypass (19%), the San Joaquin River (13%), and the eastside tributaries (2%). The largest contributor of sediment to San Francisco Bay from the Delta is the Sacramento River-Yolo Bypass system.

Existing Conditions in the Project Area

The cost-effectiveness and simplicity of sampling for turbidity rather than TSS has resulted in less TSS data in recent years. Hence, turbidity data are examined here.

Most examined locations in the Delta have had low mean values of turbidity in recent years (water years 2001–2006), with mean values typically ranging from 8 to 13 nephelometric turbidity units (NTU) (Figure 8-33). The exceptions include the major system inputs (Sacramento River at Hood [18 NTU]) and the San Joaquin River near Vernalis (23 NTU), natural outflows (Sacramento River above Point Sacramento [19 NTU] and San Joaquin River at Antioch Ship Channel [18 NTU]), and the Barker Slough Pumps (40 NTU).

Mean values for the north of Delta area were typically 5 NTU, with the exception of 19 NTU at the Sacramento River at Verona (Table 8-15). South of Delta mean values were typically 6 NTU.

Table 8-15. Turbidity Concentrations at Selected North and South of Delta Stations, Water Years 2001–2006[a]

	Turbidity (NTU)				
Location	Samples	Minimum	Maximum	Mean	Median
Sacramento River at Keswick	17	9	33	5	3
Sacramento River at Verona	18	4	68	19	12
Feather River at Oroville	5	2	10	5	4
American River at WTP	119	1	146	5	2
California Aqueduct at Check 13	69	1	23	6	6
California Aqueduct at Check 29	74	2	21	6	5

Source: California Department of Water Resources 2009b.
Notes:
NTU = nephelometric turbidity unit
WTP = water treatment plant
[a] Sample size represents water quality samples having values at or greater than the reporting limit.

Time series data indicate that turbidity values at the examined stations generally fluctuate on an annual basis (Figure 8-34 and Figure 8-35), with higher values during the months of December through March.

Regulatory criteria with respect to turbidity are as follows. The CTR has no criteria for either parameter. The secondary California drinking water MCL for turbidity in treated drinking water is 5 NTU, which has often been exceeded at the major pumping plant intakes. The San Francisco Bay Regional Water Board Basin Plan objectives for turbidity are associated with waste dischargers such that turbidity relatable to such discharge shall not increase receiving water by more than 10% in areas where natural turbidity is greater than 50 NTUs. Central Valley Water Board Basin Plan objectives are more restrictive, and are detailed in Appendix 8A. The current CALFED turbidity goal is 50 NTU for the purposes of reducing turbidity variability (CALFED Bay-Delta Program 2007b).

USEPA's Surface Water Treatment Rules require systems using surface water or groundwater under the direct influence of surface water to implement the appropriate disinfection and/or filtration techniques to minimize turbidity in treated drinking water (U.S. Environmental Protection Agency 2006a). At no time can turbidity go above 5 NTU; systems that use filtration must ensure that the turbidity go no higher than 1 NTU (0.5 NTU for conventional or direct filtration) in at least 95% of the daily samples in any month. As of January 1, 2002, turbidity may never exceed 1NTU, and must not exceed 0.3 NTU in 95% of daily samples in any month.

8.1.3.7 Ammonia

Background

Ammonia, a form of nitrogen, primarily exists in two forms: un-ionized ammonia (NH_3) and an ionized form—ammonium (NH_4^+). The equilibrium between un-ionized ammonia and ammonium depends primarily on pH, and also on temperature and salinity. Un-ionized ammonia is a gas that is toxic to animals, while ammonium is dissolved in water, and is an important nutrient for plants and algae. Both ammonium and ammonia are present in effluent from wastewater treatment plants that employ secondary treatment methods, in some types of agricultural runoff (i.e., fertilizers, animal wastes), fish and other wildlife wastes, and atmospheric depositions (Ballard et al. 2009:2).

Ammonia can be toxic to aquatic organisms at very low concentrations. Human-induced excesses in nitrogen concentrations can cause eutrophication, or increased biological production. Eutrophic conditions result in enhanced death and decay of biomass and create an oxygen demand in sediments that lowers DO concentrations in the water column (Wetzel 2001). Eutrophic conditions can also affect turbidity and, therefore, the light regime, which can cause changes in the balance of benthic and planktonic productivity.

The beneficial uses that could be affected most by ammonia concentrations include aquatic organisms (cold freshwater habitat, warm freshwater habitat, and estuarine habitat), or activities that depend on aquatic life (shellfish harvesting, commercial and sport fishing). Drinking water supplies (municipal and domestic supply) and recreational activities (water contact recreation, noncontact water recreation) are indirectly affected from nuisance eutrophication effects of ammonia (Table 8-1). See the previous sections for greater detail with respect to the relationships of DO and turbidity to water quality.

The presence of nutrients in aquatic systems promotes primary productivity through algal and macrophyte growth, which add to the concentrations of DOC and TOC in water. Organic carbon in source waters is a constituent of drinking water concern because of DBP formation during water treatment. See the organic carbon section for more on water quality concerns associated with organic carbon and DBPs. Additionally, NH_3 can form nitrogenous DBPs when combined with chlorine.

In addition to being a source of organic carbon, some species of algae can cause taste and odor problems; others produce toxins that may be harmful to humans. Recent algal blooms in the Delta have produced measurable concentrations of microcystin, a common toxin produced by cyanobacteria (Tetra Tech 2006a). There are currently no drinking water standards for algae, but some species and their toxins are included in USEPA's Drinking Water Contaminant Candidate List. The presence of algae in source waters may also decrease filtration efficiency.

Importance in the Project Area

Nutrient concentrations in Delta water are high enough that they probably do not limit algal growth (Jassby et al. 2002). However, the ecosystem-level effects of nutrient concentrations in the Delta are unclear, and some research indicates that nutrient concentrations may inhibit primary productivity (CALFED Bay-Delta Program 2008a). For example, ammonium-N is known to stimulate plant growth, but also suppress plant uptake of nitrate-N, and ultimately suppress growth of some sensitive plants. Elevated concentrations of ammonium-N and other nutrients may also benefit invasive aquatic plants in the Delta, which are controlled in Delta channels through chemical herbicides and mechanical removal (Ballard et al. 2009:6).

Since 2000, the unexpected decline of four pelagic (open-water) fishes (delta smelt, longfin smelt, juvenile striped bass, and threadfin shad) has spurred research to determine possible causes. This decline has collectively become known as the Pelagic Organism Decline (POD). This shift likely is caused by a variety of factors related to changes in climate, food webs, land use, and water project operations; ammonia/ammonium is only one of several potentially important factors (Ballard et al. 2009:1).

The composition of the phytoplankton community has generally shifted from diatoms toward green algae, cyanobacteria, and miscellaneous flagellate species (Lehman 2000). The changes in phytoplankton composition, and especially the now regularly occurring *Microcystis* blooms, have been implicated as possible factors in the decline of important Delta pelagic fish species, but the connection with ammonia is not clear (Ballard et al. 2009:5).

Wilkerson et al. (2006) concluded that the high nutrient, low chlorophyll condition in the northern and central parts of San Francisco Bay is due primarily to light availability modulated by the interaction between ammonium and nitrate, and the relative concentrations of the two forms of the dissolved inorganic nitrogen pool available to the phytoplankton. Field measurements and experiments by Dugdale et al. (2007) demonstrated that elevated ammonium concentrations in San Francisco Bay can have an inhibitory effect on nitrate uptake, limiting phytoplankton productivity.

The Sacramento Regional Wastewater Treatment Plant (SRWTP) is the largest single point source of ammonium and ammonia in the Delta. The SRWTP's output has increased with human population growth, and it has contributed to an increase in ammonium concentrations in the Delta downstream of the discharge (Ballard et al. 2009:3). The discharge from the SRWTP accounts for 90% of the ammonium load in the Sacramento River at Hood (Jassby 2008).

The results of a 2008 pilot study to assess the potential acute toxicity of ammonia and treated wastewater effluent from the SRWTP to larval delta smelt suggest that ammonia concentrations present in the Sacramento River below the SRWTP were not acutely toxic to 55-day old delta smelt. In general, un-ionized ammonia concentrations in the Delta appear to be too low to cause acute mortality of even the most sensitive species. It is unclear whether lower concentrations of ammonia may have chronic effects on species survival, growth, or reproduction (Ballard et al. 20097).

There may be a potential for toxic ammonia concentrations to be reached in very productive areas in the southern Delta or smaller productive sloughs or shallow areas throughout the Delta, when high concentrations of un-ionized ammonia coincide with warm temperatures and elevated pH (phytoplankton productivity increases pH that influences how much un-ionized ammonia is present). In addition, the potential for combined effects of un-ionized ammonia with other toxicants and stressors, and differences in fish sensitivity depending on health status, age, and physiological state add uncertainty to data analyses (Ballard et al. 2009:7).

Concern about ammonium effects in the Delta have led to focused efforts to define and assess the issue (e.g., March 2009 CALFED Science Program Workshop, August 2009 Ammonia Summit). The results of published research to date indicate that a strong link between ammonium concentrations and beneficial use impairments in the Sacramento River and/or Delta has yet to be confirmed (Foe 2009).

Existing Conditions in the Project Area

Most examined locations in the Delta have had low concentrations of ammonia-N in recent years (water years 2001–2006), with mean values typically ranging from 0.03 to 0.11 mg/L (Figure 8-36). The two exceptions are the Sacramento River at Hood and the San Joaquin River at Buckley Cove. The Hood station had a mean value of 0.27 mg/L, a median value of 0.23 mg/L, and a maximum value of 0.84 mg/L. The most likely source of the ammonia-N is the SRWTP. The Buckley Cove station had a mean value of 0.58 mg/L, a median value of 0.40 mg/L, and a maximum value of 2.94 mg/L. The most likely source of the ammonia-N is the City of Stockton Wastewater Treatment Facility; however, the City of Stockton has since installed a nitrifying biotower system that converts nearly all ammonia in the wastewater to nitrate in the final effluent that is discharged to the San Joaquin River.

Mean values for the north of Delta area ranged from 0.01 mg/L at the Feather River at Oroville to 0.07 mg/L at the Sacramento River at Keswick (Table 8-16). South of Delta mean values ranged from 0.02 to 0.03 mg/L.

Table 8-16. Ammonia Concentrations at Selected North and South of Delta Stations, Water Years 2001–2006[a]

	Ammonia (mg/L as N)				
Location	Samples	Min	Max	Mean	Median
Sacramento River at Keswick	25	0.03	0.24	0.07	0.03
Sacramento River at Verona	9	0.01	0.10	0.04	0.03
Feather River at Oroville	8	0.01	0.03	0.01	0.01
American River at WTP	14	0.01	0.06	0.02	0.02
California Aqueduct at Check 13	26	0.01	0.12	0.03	0.02
California Aqueduct at Check 29	20	0.01	0.04	0.02	0.01

Source: California Department of Water Resources 2009b.
Notes: mg/L = milligrams per liter; WTP = water treatment plant
[a] Sample size represents water quality samples having values at or greater than the reporting limit.

Time series data indicate that ammonia-N concentrations at the examined stations generally fluctuate on an annual basis (Figure 8-37 and Figure 8-38). Higher values have tended to occur during the months of November through March.

Regulatory criteria with respect to ammonia are as follows. Regarding narrative objectives, as stated in the San Francisco Bay Regional Water Board Basin Plan and Central Valley Water Board Basin Plan, ammonia might be considered a *biostimulatory substance* because it is the preferred form of nitrogen for plant nutrient uptake, and a *toxic* compound under certain circumstances (e.g., high un-ionized ammonia concentrations). There are no numerical water quality criteria for the CTR or the Central Valley Water Board Basin Plan, and there is no California drinking water MCL associated with ammonia. The San Francisco Bay Regional Water Board Basin Plan water quality objective of 0.025 mg/L ammonia-N 4-day average for freshwater refers to un-ionized ammonia, which is a function of ionized ammonia, pH, temperature, and salinity. Available data are inadequate to assess whether the sites examined herein exceeded this standard. Because the Central Valley Water Board Basin Plan and CTR lack objectives/criteria for ammonia, the Central Valley Water Board regulates ammonia through its narrative toxicity objective. Water Board staff rely on the USEPA National Recommended Water Quality Criteria for ammonia (EPA-822-R-99-014, December 1999) to numerically interpret the narrative standard with regard to ammonia.

8.1.3.8 Other Nutrients

Background

Nutrients, primarily nitrogen (N) and phosphorus (P), play a complex role in water quality (ammonia-N is discussed in the previous section) and the health of aquatic ecosystems. P is generally considered a limiting nutrient in freshwater systems, while N is generally considered a limiting nutrient in marine systems. A limiting nutrient is one that is in shorter supply for organisms that depend on nutrients for groth relative to the other nutrients, and thus increases or decreases in the limiting nutrient affect primary productivity. In freshwater rivers, P is usually bound to particles, complexing with elements such as iron. When this freshwater enters estuaries and becomes more saline, the P-iron complex disassociates and the P is released in a form that can be readily absorbed by algae. Hence there is, in many instances, adequate P available for algal growth in estuary conditions.

The beneficial uses most directly affected by nutrient concentrations include those relevant to aquatic organisms (cold freshwater habitat, warm freshwater habitat, and estuarine habitat), drinking water supplies (municipal and domestic supply), and recreational activities (water contact recreation, noncontact water recreation), which can be indirectly affected by the nuisance eutrophication effects of nutrients (Table 8-1). Aquatic life depends on the availability of nutrients; however, elevated concentrations of nutrients can cause eutrophication, as discussed in the previous sections (DO, ammonia, and turbidity and TSS).

There are presently no applicable water quality standards for P. Drinking water standards have been set for nitrate (10 mg/L) and nitrite (1 mg/L) because nitrate and nitrite can compete with oxygen for receptor sites on hemoglobin in the bloodstream, thereby interfering with normal respiration and causing effects in humans such as blue-baby syndrome.

Importance in the Project Area

Nutrients in the Delta are derived from a variety of point sources, including municipal discharges, and nonpoint sources, including agricultural and urban runoff. As discussed previously (see the *Ammonia* section), nutrient concentrations in the Delta are high enough that they are probably not a true limiting factor for algal growth. However, excessively high nutrient concentrations can also be associated with algal blooms and decreased water quality, and it is unclear if nutrient concentrations are adversely affecting primary productivity, which may be a contributing factor to POD (see the *Ammonia* section for more information on POD).

Existing Conditions in the Project Area

A conceptual model developed for the Central Valley Drinking Water Policy Workgroup (Tetra Tech 2006b) estimated nutrient concentrations across the Central Valley by averaging time series data at many sampling locations. Results indicate that total nitrogen (TN) and total phosphorus (TP) concentrations were typically higher in the San Joaquin River (approximately 1.6 mg/L and 0.16 mg/L, respectively) compared to the Sacramento River (approximately 0.4 mg/L and 0.08 mg/L, respectively). TN was typically in the form of nitrate-N. TP composition varied from high to low concentrations of particulate-P. TP concentrations showed little inter-seasonal variation for these two rivers, but higher TN concentrations were seen in the Sacramento River during wet months and in the San Joaquin River during dry months (Tetra Tech 2006b).

Overall, TN and TP concentrations in the San Joaquin River and the Delta are relatively high, and are at concentrations that would be classified as eutrophic waters. Given the abundance of nutrients, primary productivity in the Delta is fairly low (Jassby et al. 2002), suggesting that factors other than nutrients are limiting, specifically light limitation caused by turbidity levels. The San Joaquin River exhibits symptoms of eutrophic conditions, notably low DO concentrations that impair migration of cold and warm freshwater species (Jassby 2005). However, when waters from the Delta are pumped out in aqueducts for transport, or stored in reservoirs along the way, other limitingfactors may disappear and high levels of algal growth may result (Tetra Tech 2006b).

Although effects on water quality are usually related to concentrations of constituents, load estimates may facilitate identification of important sources. Tributary loads were found to vary substantially between wet and dry years, with loads from the Sacramento River exceeding the San Joaquin River loads by nearly a factor of two or greater, especially in dry years (Tetra Tech 2006b). Forest/rangeland loads may dominate the overall N loads for the Sacramento Basin and agricultural loads may dominate in the overall N loads to the San Joaquin Basin, particularly for wet years. Point source loads from wastewater discharges may contribute nearly half or more of the overall N and P loads during dry years in both basins, and possibly during wet years for P in the San Joaquin Basin. Current estimates for in-Delta contribution of nutrients from agriculture on the Delta islands are small compared to tributary sources (Tetra Tech 2006b).

TN and TP are often subdivided into different chemical species. Filtered water samples consist of dissolved organic nitrogen, nitrate-N (NO_3-N), nitrite-N (NO_2-N), ammonia (NH_3-N), dissolved organic phosphorus, and ortho-phosphorus (ortho-P). Due in part to their immediate biological availability to algae, chemical species typically analyzed by water quality monitoring programs include NH_3-N (see previous section), the combined NO_3/NO_2-N fraction (because of ease of analysis; in oxygenated waters the sample is typically dominated by NO_3-N), and ortho-P.

Nitrate/Nitrite

Most examined locations in the northern half of the Plan Area, as well as the export area of the Delta, have had low concentrations of NO_3/NO_2-N in recent years (water years 2001–2006), with mean values typically ranging from 0.28 to 0.40 mg/L (Figure 8-39). Concentrations in the southern half of the Delta, however, were typically higher. For example, the Contra Costa Pump #1 had a mean value of 0.46 mg/L and the Banks pumping plant had a mean value of 0.56 mg/L. The highest mean values were seen at the San Joaquin River near Vernalis (1.34 mg/L) and San Joaquin River at Buckley Cove (1.63 mg/L).

Mean values for the north of Delta area ranged from 0.6 mg/L at the Feather River at Oroville to 0.12 mg/L at the Sacramento River at Verona (Table 8-17). South of Delta mean values were higher than north of Delta stations examined (0.62 to 0.64 mg/L), comparable to the mean at the Harvey O. Banks headworks (0.56 mg/L, Figure 8-39).

Table 8-17. Nitrate/Nitrite Concentrations at Selected North and South of Delta Stations, Water Years 2001–2006[a]

	Nitrate/Nitrite (mg/L as N)				
Location	Samples	Minimum	Maximum	Mean	Median
Sacramento River at Keswick	44	0.03	0.99	0.10	0.08
Sacramento River at Verona	19	0.02	0.34	0.12	0.09
Feather River at Oroville	40	0.01	0.20	0.06	0.04
American River at WTP	39	0.01	0.36	0.07	0.05
California Aqueduct at Check 13	27	0.18	1.50	0.62	0.59
California Aqueduct at Check 29	29	0.19	1.70	0.64	0.50

Source: California Department of Water Resources 2009b.
Notes: mg/L = milligrams per liter; WTP = water treatment plant
[a] Sample size represents water quality samples having values at or greater than the reporting limit.

Time series data indicate that NO_3/NO_2-N concentrations at the examined stations generally fluctuate on an annual basis (Figure 8-40 and Figure 8-41). Higher values have tended to occur during the months of November through March.

Orthophosphorus

Most examined locations have had low concentrations of ortho-P in recent years (water years 2001–2006), with mean values typically ranging from 0.04 to 0.08 mg/L (Figure 8-42). Exceptions include the Barker Slough Pumps (mean 0.10 mg/L), the San Joaquin River near Vernalis (mean 0.11 mg/L), and San Joaquin River at Buckley Cove (0.16 mg/L).

Mean values for the north of Delta area were all 0.02 mg/L (Table 8-18). South of Delta mean values were higher than north of Delta and Plan Area stations examined, with mean values of 0.08 to 0.10 mg/L (Harvey O. Banks headworks: 0.07 mg/L; Figure 8-42).

Table 8-18. Orthophosphorus Concentrations at Selected North and South of Delta Stations, Water Years 2001–2006[a]

	Orthophosphorus (mg/L)				
Location	Samples	Minimum	Maximum	Mean	Median
Sacramento River at Keswick	41	0.01	0.03	0.02	0.02
Sacramento River at Verona	18	0.01	0.05	0.02	0.02
Feather River at Oroville	7	0.01	0.05	0.02	0.01
American River at WTP	8	0.01	0.05	0.02	0.01
California Aqueduct at Check 13	27	0.05	0.15	0.08	0.07
California Aqueduct at Check 29	2	0.04	0.15	0.10	0.10

Source: California Department of Water Resources 2009b.
Notes: mg/L = milligrams per liter; WTP = water treatment plant
[a] Sample size represents water quality samples having values at or greater than the reporting limit.

Time series data indicate that ortho-P concentrations at the examined stations generally fluctuate on an annual basis (Figure 8-43 and Figure 8-44). However, some stations have seen higher values during the summer and fall months, while other stations have seen higher values during the winter and spring months.

Total Phosphorus

Most examined Delta locations have had low concentrations of TP in recent years (water years 2001–2006), with mean values typically ranging from 0.08 to 0.11 mg/L (Figure 8-45). As seen with ortho-P, exceptions include the Barker Slough Pumps (mean 0.20 mg/L), the San Joaquin River near Vernalis (mean 0.19 mg/L), and San Joaquin River at Buckley Cove (0.25 mg/L).

Mean values for the north of Delta area were between 0.06 and 0.08 mg/L, with the exception of a lower value of 0.02 mg/L at the American River at WTP (Table 8-19). South of Delta mean values were higher than north of Delta and Plan Area stations examined, with mean values (0.10 mg/L) near those seen in the Plan Area.

Table 8-19. Total Phosphorus Concentrations at Selected North and South of Delta Stations, Water Years 2001–2006[a]

	Total Phosphorus (mg/L)				
Location	Samples	Minimum	Maximum	Mean	Median
Sacramento River at Keswick	44	0.01	0.89	0.06	0.02
Sacramento River at Verona	19	0.02	0.20	0.06	0.04
Feather River at Oroville	36	0.01	1.80	0.08	0.02
American River at WTP	37	0.01	0.10	0.02	0.02
California Aqueduct at Check 13	27	0.06	0.21	0.10	0.10
California Aqueduct at Check 29	29	0.06	0.22	0.10	0.09

Source: California Department of Water Resources 2009b.
Notes:
mg/L = milligrams per liter
WTP = water treatment plant
[a] Sample size represents water quality samples having values at or greater than the reporting limit.

Time series data indicate that TP concentrations at the examined stations generally did not fluctuate in a consistent manner on an annual basis (Figures 8-46 and 8-47).

Regulatory criteria with respect to N and P are as follows. Regarding Basin Plan narrative objectives, N and/or P could be considered *biostimulatory substances* because they are plant nutrients. There are no numerical water quality criteria for nutrients in the CTR or the Central Valley Water Board Basin Plan. The San Francisco Bay Regional Water Board Basin Plan has objectives of 30 mg/L NO_3 plus NH_4 as N for agricultural supply—irrigation, and 100 mg/L NO_3/NO_2-N for agricultural supply—livestock watering. The California drinking water MCL is 1 mg/L for NO_2-N and 10 mg/L for NO_3-N. Individual measurements of NO_2-N and NO_3-N were scarce, so assessment of the MCL values is not possible. NO_3/NO_2-N and NH_4-N data are readily available; there were no exceedances with respect to the San Francisco Bay Regional Water Board Basin Plan water quality objectives noted.

8.1.3.9 Mercury

Background

Mercury and its biologically active methylated form is an element of statewide concern. Mercury present in the Delta, its tributaries, Suisun Marsh, and San Francisco Bay today is derived from both current processes and as a result of historical deposition. The majority of the mercury present (and hence the impacts on beneficial uses) are the result of historical mining mercury ore in the Coast Ranges (via Putah and Cache Creeks to the Yolo Bypass) and the extensive use of elemental mercury to aid gold extraction processes in the Sierra Nevada (via Sacramento, San Joaquin, Cosumnes, and Mokelumne Rivers) (Alpers et al. 2008:6; Wiener et al. 2003). Residual mercury in soils impacted by historic mining continues to contribute to mercury concentrations in water and sediments of the Delta and its tributaries. The mercury supplied from historical gold mining processes appears to be the most bioavailable of the two primary sources, because that mercury was purified prior to use rather than left as more refractory ore and tailings(Central Valley Regional Water Quality Control Board 2008a).

The bioavailability and toxicity of elemental mercury (from whatever primary source) is greatly enhanced through the natural, bacterial conversion of mercury to methylmercury in marshlands or wetlands. These stagnant locations with reduced oxygen concentrations promote chemical reduction processes that make methylation possible.

Areas of enhanced bioavailability and toxicity of mercury (created through the mercury methylation process) exist in the Delta, and elevated mercury concentrations in fish tissue produce subsequent exposure and risk to humans and wildlife. Consequently, the beneficial uses most directly affected by mercury include shellfish harvesting and commercial and sport fishing activities that pose a human health concern, and wildlife habitat and rare, threatened, and/or endangered species resources that can be exposed to bioaccumulation of mercury (Table 8-1). Because of these concerns, mercury was the first TMDL approved for San Francisco Bay in 2007 (San Francisco Bay Regional Water Quality Control Board 2006). The Delta methylmercury TMDL was approved by the Central Valley Water Board in 2010 and is awaiting approval from the State Water Board, USEPA, and Office of Administrative Law (OAL). The Delta and Suisun Marsh are both listed as impaired water bodies on the Section 303(d) lists for mercury in fish tissue (State Water Resources Control Board 2011).

Importance in the Project Area

Limiting characterization to the routine monitoring of total mercury waterborne concentrations is inadequate to determine mercury bioavailability. A conceptual model is needed to determine the importance of sediment, fish tissue, and methylated mercury as measures of exposure and risk in the system. A description of this model follows, and then concentrations in sediment and fish tissues are detailed.

Conceptual Model of Mercury and Methylmercury Transport and Fate in the Delta

Several conceptual models have been created for the Delta to describe important linkages among waterborne loading, waterborne concentrations, and water, sediment, and biotic processing of mercury and methylmercury (Ecosystem Restoration Program Delta Regional Ecosystem Restoration Implementation Plan [ERP DRERIP]). Figure 8-48 shows the important linkages, pathways, and relative importance of each in determining bioavailability; the important links between sediment processes and biotic uptake are emphasized. Mercury is strongly particle-associated and tends to settle and accumulate in sediment deposition areas that facilitate mercury methylation by sulfur-reducing bacteria. From that point in the cycle, diet (rather than waterborne concentration) is the primary route for methylmercury exposure to fish, wildlife, and humans.

The goal of mercury conceptual models (such as Alpers et al. 2008:ii) and plans created for integrated mercury investigations as part of Delta restoration efforts (such as Wiener et al. 2003) has been to identify linkages that can then be used to guide restoration efforts toward the least harmful alternatives (i.e., the alternative with the least potential to exacerbate mercury-related effects). Aside from controlling upstream sources of mercury and methylmercury loading to the Delta, it may also be important to limit the conversion of elemental mercury to the more bioaccumulative and toxic methylmercury in Delta environments. For that reason, the Central Valley Water Board has focused on controlling methylmercury to protect beneficial uses in the Delta (Central Valley Water Board 2008b). As shown in Figure 8-48, a series of drivers related to water quality and sediment determines methylmercury production and uptake in biota and subsequent health effects on humans or wildlife. At every step of the process, opportunities exist to modify final outcomes and minimize impacts from mercury toxicity.

As suggested in Figure 8-48 and summarized from the local and general literature (as discussed and cited in Alpers et al. 2008), the following environmental characteristics are most important for determining risks to fish, wildlife, and humans from waterborne mercury contamination in the Delta.

- Source of inorganic mercury (atmospheric and gold mining operations are most bioavailable).
- Nutrient enrichment (high nutrient supply, algal growth, and eutrophication favor mercury uptake, bioaccumulation, and methylation).
- Water column DO (oxygen depletion in water or surface sediments favors methylation).
- Sediment organic content and grain size (small size fractions and more organic characteristics favor methylation).
- Water residence time and sediment accumulation (high residence time and sediment deposition areas favor methylation).
- Periodic drying and wetting (seasonal or annual flooding enhances methylmercury production and food chain bioaccumulation in certain areas of the Delta) (Slotton et al. 2007).
- Fish species and age structure (top predators and older, larger fish accumulate higher tissue concentrations of methylmercury).

Existing Conditions in the Study Area

Water Concentrations

Water quality data from the Delta and Suisun Marsh include records of mercury and methylmercury waterborne concentrations as total or filtered water fractions. Water quality summary information since 1999 is shown in Table 8-20. The general pattern of mercury waterborne loading to the Delta shows the dominance of mercury mining sources via Cache Creek and Yolo Bypass (Central Valley Regional Water Quality Control Board 2008b); however, the waterborne average concentrations do not reflect the same pattern as loads (Table 8-21). Instead, the eastside tributaries and San Joaquin River show higher mercury and methylmercury concentrations than the Sacramento River inputs.

Sediment Concentrations

It has been estimated that the flux of methylmercury from Delta sediments contributes up to 36% of the waterborne methylmercury load in the Delta (Central Valley Regional Water Quality Control Board 2008a). Therefore, the spatial variability of mercury and methylmercury in sediments is an important characteristic of the Delta's current condition for mercury exposure, and could be important for determining future mercury risk. Table8-21 shows the pattern of surface sediment mercury throughout the Delta and Suisun Bay.

The CALFED sediment mercury study reported that total mercury in sediments varied spatially but not seasonally (Heim et al. 2007). Total mercury concentrations (the sum of elemental and methylmercury) in sediment were most elevated in the influent tributary streams and Suisun Bay, as compared to the central and southern Delta.

In contrast, methylmercury showed both spatial and seasonal variations in concentration. The biologically mediated nature of mercury methylation was apparently important in creating a seasonal summer maximum in sediment methylmercury concentrations. Methylmercury concentrations were highest in the mid-Delta interior marshes (compared to peripheral rivers) and varied on a small scale, with the highest concentrations in mid-marsh.

The pattern of mercury transport and fate in the Delta is one of waterborne loading from historical source waters (and runoff from historically affected soils) to the interior Delta, followed by the accumulation of fine sediments in the marsh and subsequent methylation of elemental mercury in those locations (Heim et al. 2007).

Fish Tissue Concentrations

Resident Delta fish accumulate mercury primarily through dietary exposure; larger, piscivorous (fish-eating) fish show the greatest levels of tissue mercury. In contrast to anadromous fish (migratory species), the resident fish experience constant exposure to local mercury sources. Resident species include larger fish with human health exposure (such as largemouth bass) and smaller, forage fish (such as inland silversides). Fish tissues are the ultimate route of exposure to mercury for aquatic-dependent birds and mammals, and to humans who consume locally caught fish.

The mercury conceptual model illustrates these principals. Fish tissue concentrations are the final outcomes of the mercury conceptual model (Figure 8-48), and they show substantial levels of contamination throughout the Delta. For example, the tissue concentrations of mercury in largemouth bass are shown as a spatial distribution throughout the Delta in Figure 8-49 (1999–2000 data). Note that the Sacramento River inflows and Cosumnes River were the areas of highest fish tissue bioaccumulation, whereas these larger sport fish had uniformly lower tissue concentrations in the central Delta.

Table 8-20. Mercury and Methylmercury Surface Water Concentrations at Tributary Inputs and the Delta's Major Outputs

	Mercury Concentration (ng/L)						Methylmercury Concentration (ng/L)					
Site	No. of Samples	Min.	Max.	Mean	Year Collected	Source	No. of Samples	Min.	Max.	Mean	Year Collected	Source
Mercury Concentrations for Tributary Inputs												
Sacramento River at Keswick	26	0.2	2.7	0.5	2006–2007	DWR Website 2010	—	—	—	—	—	—
Sacramento River at Keswick[a]	—	—	—	—	—	—	—	—	—	—	—	—
Feather River at Oroville	5	0.2	0.7	0.4	2006–2007	DWR Website 2010	—	—	—	—	—	—
Feather River at Oroville[a]	—	—	—	—	—	—	—	—	—	—	—	—
Sacramento River at Verona	5	0.8	2.6	1.6	2006–2007	DWR Website 2010	—	—	—	—	—	—
Sacramento River at Verona[a]	—	—	—	—	—	—	—	—	—	—	—	—
Sacramento River at Freeport	45	1.2	30.6	4.1	1999–2002	Central Valley Water Board 2008a	36	0.05	0.24	0.10	2000–2003	Central Valley Water Board 2008a
Sacramento River at Freeport[a]	0	—	—	—	—	—	1	0.03	0.03	0.03	2000	Central Valley Water Board 2008a
San Joaquin River at Vernalis	49	3.1	21.7	7.6	2000–2004	BDAT 2010; Central Valley Water Board 2008a	49	0.09	0.26	0.15	2000–2001, 2003–2004	BDAT 2010; Central Valley Water Board 2008a
San Joaquin River at Vernalis[a]	19	0.3	3.0	0.8	2000–2002	BDAT 2010; USGS Website 2010	25	0.01	0.08	0.03	2000–2002	BDAT 2010; Central Valley Water Board 2008a; USGS Website 2010

	Mercury Concentration (ng/L)						Methylmercury Concentration (ng/L)					
Site	No. of Samples	Min.	Max.	Mean	Year Collected	Source	No. of Samples	Min.	Max.	Mean	Year Collected	Source
Mokelumne River at I-5	21	0.3	12.0	4.5	2000, 2001, 2003	Central Valley Water Board 2008a	23	0.02	0.32	0.12	2000, 2001, 2003	Central Valley Water Board 2008a
Mokelumne River at I-5[a]	0	—	—	—	—	—	8	0.02	0.17	0.06	2000	Central Valley Water Board 2008a
Cosumnes River at Michigan Bar[a]	1	1.4	1.4	1.4	2002	USGS Website 2010	1	0.41	0.41	0.41	2002	USGS Website 2010
Calaveras River at Rail Road upstream of West Lane	4	13	26	20	2003–2004	Central Valley Water Board 2008a	4	0.11	1.9	0.14	2003–2004	Central Valley Water Board 2008a
Mercury Concentrations for Delta's Major Outputs												
Delta-Mendota Canal at Byron Highway	23	1.9	6	3.3	2000, 2001, 2003	Central Valley Water Board 2008a	21	0.01	0.17	0.05	2000, 2001, 2003	Central Valley Water Board 2008a
Delta-Mendota Canal at Byron Highway[a]	0	—	—	—	—	—	8	0.02	0.09	0.03	2000	Central Valley Water Board 2008a
SWP	20	1.2	7.2	2.5	2000, 2001, 2003	Central Valley Water Board 2008a	20	0.01	0.14	0.04	2000, 2001, 2003	Central Valley Water Board 2008a
SWP[a]	0	—	—	—	—	—	8	0.02	0.08	0.03	2000	Central Valley Water Board 2008a
X2	20	4	49	15	2000, 2001, 2003	Central Valley Water Board 2008a	22	0.007	0.24	0.05	2000, 2001, 2003	Central Valley Water Board 2008a
X2[a]	0	—	—	—	—	—	8	0.02	0.06	0.03	2000	Central Valley Water Board 2008a
Suisun Bay	34	2.52	35.24	9.43	2000–2008	SFEI Website 2010	36	8E-05	0.18	0.03	2000–2008	SFEI Website 2010

	Mercury Concentration (ng/L)						Methylmercury Concentration (ng/L)					
Site	No. of Samples	Min.	Max.	Mean	Year Collected	Source	No. of Samples	Min.	Max.	Mean	Year Collected	Source
Suisun Bay[a]	35	0.16	4.80	0.84	2000–2008	SFEI Website 2010	32	8E-05	0.10	0.01	2000, 2002–2008	SFEI Website 2010
California Aqueduct Check 13	—	—	—	—	—	—	—	—	—	—	—	—
California Aqueduct Check 13[a]	36	0.2[b]	0.2[b]	0.2[b]	2000–2005	DWR Website 2010	—	—	—	—	—	—
California Aqueduct Check 29	—	—	—	—	—	—	—	—	—	—	—	—
California Aqueduct Check 29[a]	152	0.2[b]	0.2[b]	0.2[b]	2000–2010	DWR Website 2010	—	—	—	—	—	—

Sources: BDAT 2010; Central Valley Regional Water Quality Control Board 2008a; DWR Website 2010; SFEI Website 2010; USGS Website 2010.

Notes: Max. = maximum, Min. = minimum, ng/L = nanograms per liter.

[a] Dissolved concentration of analyte.

[b] It is assumed that the units were reported incorrectly for the site.

Table 8-21. Mercury and Methylmercury Sediment Concentrations for Tributary Inputs, the Delta, and Suisun Bay

		Total Mercury (ng/g Dry Weight)					Methylmercury (ng/g Dry Weight)				
Site	Sample Type	Samples	Min.	Max.	Mean	Year	Samples	Min.	Max.	Mean	Year
Concentrations at Tributary Inputs											
Sacramento River, Freeport[a]	Colloid	4	140	290	208	1996–1997	—	—	—	—	—
Sacramento River, Freeport[a]	Bed Sediment	1	267	267	267	1996–1997	—	—	—	—	—
Concentrations in Delta and Suisun Bay											
North Delta[b]	Surficial Sediment	11	104	320	170	1999	11	0.12	0.64	0.35	1999
East Delta[b]	Surficial Sediment	12	10.5	340	110	1999	9	0.02	0.68	0.3	1999
Central and West Delta[b]	Surficial Sediment	15	10.5	370	77	1999	12	0.019	1.1	0.36	1999
Central and West Delta[c]	Surficial Sediment	18	16.5	417	106	2000–2008	18	0.02	0.7	0.11	2000–2008
Suisun Bay[b]	Surficial Sediment	21	66	580	270	1999	20	0.019	9.3	0.45	1999
Suisun Bay[c]	Surficial Sediment	69	0.03	413	114	2002–2007	69	0.004	0.82	0.13	2000–2008

Sources: Heim et al. 2007; SFEI Website 2010; USGS Website 2009.

Notes:

Max. = maximum

Min. = minimum

ng/g = nanograms per gram

[a] Source: USGS Website 2009

[b] Source: Heim et al. 2007

[c] Source: SFEI Website 2010

Larger, piscivorous resident fish, in general, provide a good record of fish tissue mercury as a baseline condition for the Delta. Largemouth bass were chosen because they are popular sport fish, top predators, live for several years, and tend to stay in the same area (exhibit high site fidelity). Consequently, they are excellent indicators of long-term average mercury exposure, risk, and spatial pattern for ecological and human health. Results from a study of mercury in sport fish from the Delta region found the median largemouth bass tissue mercury concentration to be 0.53 mg mercury per kilogram (Hg/kg) wet weight (Davis et al. 2008). Recent summaries from tributary inputs to the Delta reveal similar or higher average bass concentrations than this Delta-wide average (Table 8-22).

Current fish tissue concentrations thus exceed both adopted regulatory standards and guidance from the EPA. The draft Delta TMDL for methylmercury, the Central Valley Water Board has recommended fish tissue goals (fillet concentrations, wet weight mercury) of 0.24 mg Hg/kg wet weight in trophic level 4 fish (adult, top predatory sport fish, such as largemouth bass) (Central Valley Regional Water Quality Control Board 2008b). These values are slightly lower than USEPA's national recommended water quality criterion for fish tissue of 0.3 mg Hg/kg wet weight for protection of human health and wildlife (U.S. Environmental Protection Agency 2001). Therefore, the Delta average for largemouth bass fillet concentrations in the Davis et al. study exceeds both recommended safe consumption guidelines.

Table 8-22. Mercury Concentrations in Largemouth Bass Fillets for Tributary Inputs

		Length (mm)			Concentration (mg Hg/kg Wet Weight)			
Site	Fish	Min.	Max.	Mean	Min.	Max.	Mean	Year
San Joaquin River at and downstream of Vernalis	40	226	530	325	0.21	1.4	0.56	1998–2000
Mokelumne River downstream of Cosumnes River	22	210	425	331	0.31	1.6	0.83	1999–2000
Cosumnes River	19	201	485	329	0.34	2.1	0.87	1999–2000

Source: Central Valley Regional Water Quality Control Board 2008a.

Notes:

Max = maximum
mg Hg/kg = milligrams mercury per kilogram
Min = minimum
mm = millimeters

Surprisingly, spatial patterns of mercury bioaccumulation in larger piscivorous sport fish do not show a clear link to zones of active sediment methylation in the Delta. In the Davis et al. study, the highest levels of fish tissue concentrations were found in the north Delta, Cosumnes River, and San Joaquin River, and lower fish tissue concentrations were found in the central, marsh-like Delta locations (Davis et al. 2008). The pattern seems to reflect the importance of source waters of methylmercury more than areas of secondary methylation in marshy locations or wetlands. In fact, in a related comprehensive study, Delta sport fish (including largemouth bass) mercury concentrations were found to not directly relate to the presence of wetlands. The authors found that the data "contradicted the prevailing notion that wetlands generally increase methylmercury accumulation in the food web" (Melwani et al. 2007). Nevertheless, the authors acknowledged the complexity of developing such relationships on a watershed scale; small-scale local factors may be the most important determinants of mercury bioaccumulation. In a subsequent study, the same authors suggest that in the case of the Delta, waterborne methylmercury may be a more important determinant of fish bioaccumulation than sediment mercury and the associated sites where methylation occurs (Melwani et al. 2009). Furthermore, laboratory studies of mercury uptake in Delta species indicate that much higher assimilation and uptake was observed in waters of lower DOC (as might be expected from the tributaries versus the interior Delta) (Pickhardt et al. 2006). This finding may help explain the dissimilar spatial pattern between sediment and fish methylmercury in the areas studied; waterborne methylmercury loading may be more important than sediment methylation in explaining the patterns of fish mercury bioaccumulation in the Delta.

In addition to human exposure as estimated from large-fish monitoring, the monitoring of whole-body fish tissues from various smaller species provides slightly different information. Monitoring of these so-called *biosentinel species*, such as inland silversides, prickly sculpin, and juvenile largemouth bass, demonstrates the variation in mercury bioaccumulation over small spatial scales and seasonal time frames (Slotton et al. 2007). The fish were juveniles of predatory fish or were various short-lived, smaller species and exhibited high site fidelity; thus, they were good monitors of spatial patterns and short time exposure. They were good indicators of short-term seasonal or interannual exposure patterns. To date, the ongoing biosentinel monitoring program (Slotton et al. 2007) has made these key findings.

- Episodic, aperiodic, or nonroutine flooding (such as seasonal high flows, extremely high tides, and managed marsh flooding) of formerly dry sediments leads to enhanced methylmercury exposure in some areas.
- The general pattern of bioaccumulation was higher fish tissue mercury concentrations in Suisun Marsh, Cosumnes River, and Yolo Bypass, but lower tissue concentrations in the central Delta (similar to sport fish results).
- Large differences occurred in fish tissue concentrations from year to year in Suisun Marsh associated with large variations in the extent of annual flooding.

The current pattern of mercury bioaccumulation in fish in the Delta and Suisun Marsh demonstrates the response to enhanced sources of mercury and methylmercury from water, sediment, and dietary pathways. Larger, piscivorous fish almost uniformly exhibit greater tissue mercury concentrations than human diet consumption guidelines, and are linked to sources of influent loading (Central Valley Regional Water Quality Control Board 2008b). Smaller, short-lived fish demonstrate clear spatial patterns of bioaccumulation and the effects of enhanced mercury exposure following the flooding of usually dry areas (Slotton et al. 2007).

Regulatory criteria with respect to mercury are as follows. Applicable water quality criteria for judging the degree of contamination and effects of future changes in concentrations include the following.

- The CTR contains criteria for human health protection of 50 ng/L for freshwater and 51 ng/L for saltwater, which are expressed in the total recoverable form of the metal.
- The national recommended water quality criterion for total mercury is 770 ng/L to protect from chronic exposure to freshwater aquatic life and 940 ng/L for marine life (U.S. Environmental Protection Agency 2006b).

- The Delta methylmercury TMDL recommended water column concentration of methylmercury, protective of fish bioaccumulation, is 0.06 ng/L (Central Valley Regional Water Quality Control Board 2008b).
- The San Francisco Bay mercury TMDL recommended water column concentration of total mercury is 25 ng/L (4-day average).

A comparison to Table 8-21 shows that the total mercury criterion (25 ng/L) is exceeded in the Sacramento River at Freeport, the Calaveras River, Suisun Bay, and Delta exports. In contrast, many of the mean and maximum methylmercury concentrations in water exceed the suggested guidelines for aquatic life (0.06 ng/L) and human health (through fish consumption).

Sediment concentrations can be judged against the Section 303(d) list screening as used by the Central Valley Water Board, based on the consensus screening value of 1.06 mg Hg/kg dry weight (1,060 ng/g) (MacDonald et al. 2000). Note that all total mercury values in Table 8-22 are below this screening value. However, this does not account for the complicated exposure pathways and methylation, which drive uptake and bioaccumulation into the food chain (Figure 8-48) more than does the total mercury concentrations in bulk sediment. Instead, sediment concentrations of mercury and methylmercury can serve as weights of evidence for differences among areas in mercury *exposure potential* from in-place or resuspended sediments.

The Delta TMDL recommendation for small, whole-fish mercury content for protection of fish and wildlife is 0.03 mg Hg/kg wet weight (Central Valley Regional Water Quality Control Board 2008b). This is in comparison to 2005–2006 Mississippi silversides whole-body mercury concentrations of 0.03 to 0.06 mg Hg/kg wet weight in the central Delta, 0.17 mg Hg/kg wet weight in Yolo Bypass, and up to 0.20 mg Hg/kg wet weight at the Cosumnes River site (Slotton et al. 2007). Most of these small fish from the Delta and Suisun Marsh exceeded the recommended Delta TMDL small-fish guideline concentrations for mercury.

8.1.3.10 Selenium

Background

Selenium is a constituent of concern in the Delta, the lower San Joaquin River, and San Francisco Bay for potential effects on water quality, aquatic and terrestrial resources, and indirectly to human health. Because of the known effects of selenium bioaccumulation from aquatic organisms to higher trophic levels in the foodchain, the wildlife habitat and rare, threatened, or endangered species beneficial uses are the most sensitive receptors to selenium exposure. Examples of those effects include reduced hatchability of fertile eggs and the development of severe, often lethal, embryo deformities in fish and birds (DOI 1998; Ohlendorf 2003). Selenium also affects other aquatic life beneficial uses, including warm freshwater habitat; cold freshwater habitat; migration of aquatic organisms; spawning, reproduction, and/or early development; and estuarine habitat. Additional nonhabitat beneficial uses that may be affected include freshwater replenishment, municipal and domestic supply, and agricultural supply.

The State Water Board lists the western Delta as having impaired water quality for selenium (under Section 303[d]) (State Water Resources Control Board 2011). The Central Valley Regional Water Quality Control Board completed a TMDL for selenium in the lower San Joaquin River (downstream of the Merced River) in 2001 and Salt Slough in 1997/1999, and USEPA approved this in 2002 (Central Valley Regional Water Quality Control Board 2001, 2009d).

The Central Valley Regional Water Quality Control Board adopted amendments to the WQCP for the Sacramento River and San Joaquin River basinsto address selenium control in the San Joaquin River basin in May 2010 (Central Valley Regional Water Quality Control Board 2010a), and the State Water Board approved the amendments in October (State Water Quality Control Board 2010d, 2010e). The intent is to modify the compliance time schedule for discharges regulated under waste discharge requirements to meet the selenium objective or comply with a prohibition of discharge of agriculturalsubsurfacedrainage to Mud Slough (north), tributary to the San Joaquin River, in Merced County. The proposed amendments and supporting staff report include environmental documentation required under California Public Resources Code 21080.5 and 23 CCR 3775–3782. The environmental documentation is informed by the environmental analysis conducted by Reclamation and the San Luis and Delta Mendota Water Authority, dated December 21, 2009 (Bureau of Reclamation 2009c), which was prepared in compliance with the same legal provisions with regard to the use of the federally owned San Luis Drain. The environmental analysis concluded that, with the agreed-upon mitigation measures, the amendments would have no significant effects on the environment. The proposed Basin Plan amendments are administrative in nature and will not alter any water quality objective, program goal, policy, or other scientific underpinning of the selenium control program for the San Joaquin River.

The San Francisco Bay Regional Water Board is conducting a new TMDL project to address selenium toxicity in the North San Francisco Bay (North Bay), defined to include a portion of the Delta, Suisun Bay, Carquinez Strait, San Pablo Bay, and the Central Bay (San Francisco Bay Regional Water Quality Control Board 2009).The North Bay selenium TMDL will identify and characterize selenium sources to the North Bay and the processes that control the uptake of selenium by wildlife. The TMDL will quantify selenium loads, develop and assign waste load and load allocations among sources, and include an implementation plan designed to achieve the TMDL and protect beneficial uses.

Importance in the Project Area

Selenium is an essential trace element for human and other animal nutrition that occurs naturally in the environment. In the Delta watershed, selenium is most enriched in marine sedimentary rocks of the Coast Ranges on the western side of the San Joaquin Valley (Presser and Piper 1998). Because of erosion of the selenium-enriched sedimentary rock and irrigation practices used in the Central Valley, selenium concentrations in this watershed are high. It is also highly bioaccumulative, and is of greatest concern because it can cause chronic toxicity (especially impaired reproduction) in fish and aquatic birds (Ohlendorf 2003; San Francisco Bay Regional Water Quality Control Board 2009). Bioaccumulation of selenium in diving ducks has led to health advisories for local hunters. Monitoring of selenium in ducks, fish, and invertebrates in the northern part of the San Francisco Bay has revealed concentrations that could cause health risks to people and wildlife. Although the entire Bay is listed as impaired by selenium, the TMDL for selenium in the Bay will focus on the North Bay because sources there are substantially different from sources in the South Bay. The primary source of selenium loading to the North Bay and the Suisun Bay area is from the Delta (Lucas and Stewart 2007).

Selenium concentrations in whole-body fish or fish eggs are most useful for evaluating risks to fish, and concentrations in bird eggs are most useful for evaluating risks to birds (Skorupa and Ohlendorf 1991; DOI 1998; Ohlendorf 2003). Analyses of dietary items (such as benthic [sediment-associated] or water-column invertebrates) also can be used for evaluating risks through dietary exposure, although with less certainty than when using concentrations measured in fish or birds. When data are not available for the target receptors (fish and birds) or for their diets, concentrations can be estimated from selenium in water and suspended particulates. However, such modeling further increases the uncertainties in predictions of risk.

For evaluation of risks to human health, analyses of fish fillets are most common, although the fish should be analyzed in the form that people may eat (for example, for some species or ethnic groups, whole-body analyses may be appropriate) (California Office of Environmental Health Hazard Assessment 2008).

Existing Conditions in the Project Area

Water Concentrations

Selenium has been monitored most consistently at the mouth of the San Joaquin River at Vernalis (Table 8-23) mainly because agricultural drainage in the San Joaquin Valley is the primary source of selenium to the Delta (Cutter and Cutter 2004; Presser and Luoma 2006; Bureau of Reclamation 2006; Entrix 2008; Tetra Tech 2008).

Selenium also has been monitored frequently at selected locations north and south of the Delta and occasionally at a few locations in the Delta. In addition, a CALFED study (Lucas and Stewart 2007) provided results of several cruises within the project area during 2003–2004, focused primarily on the waterways between Stockton, Rio Vista, and Benicia (Table 8-24 and Figure 8-50).

Total selenium concentrations measured on a weekly basis by the Central Valley Water Board's Surface Water Ambient Monitoring Program at Vernalis (Airport Way monitoring station) show the variation in concentrations by season and year (Figure 8-51).

Before implementation of the Grassland Bypass Project in September 1996, selenium concentrations at Vernalis were commonly twice as high as those shown in Figure 8-51. Implementation of the Grassland Bypass Project has led to a 60% decrease in selenium loads from the Grassland Drainage Area in comparison to pre-project conditions (Tetra Tech 2008; SFEI Website 2008). Cutter and Cutter (2004) reported a decreased mean concentration of 0.68 µg/L at Vernalis from 1997 to 2000 in comparison to values shown in Table 8-23 and data from a previous study from 1984 to 1988 (1.25 µg/L). It is likely that the selenium concentration at Vernalis will continue to decrease with continued operation of the Grassland Bypass Project and achievement of Basin Plan objectives in the amendment described above (Central Valley Regional Water Quality Control Baord 2010a; State Water Resources Control Board 2010d, 2010e).

Much less sampling has been conducted for selenium analysis in the Sacramento River. The most recent available data for locations in or near the Delta are from Freeport (Table 8-23). A mean concentration of 0.072 µg/L was reported for Freeport in 1984 to 1988 and 1997 to 2000 (years combined, with no apparent difference between the two periods), but the data are not available (Cutter and Cutter 2004). Because of the limited data from Freeport, additional values are provided from the Sacramento River at Verona and Knights Landing (upstream from Sacramento, but reflecting quality of water that may enter the Yolo Bypass during flooding). The maximum selenium concentration at those locations was 1.0 µg/L, and the mean concentrations were all less than 0.5 µg/L. Only limited selenium data are available for other major tributaries to the eastern Delta.

Table 8-23. Selenium Concentrations in Surface Water in the Project Area

Site	No. of Samples	Selenium Concentration (µg/L) Min.	Max.	Mean	Years	Source
Selenium Concentrations North of the Delta						
Sacramento River at Keswick	86	0.061	0.40	0.21	2003–2008	DWR Website 2010
Sacramento River at Keswick[a]	80	0.090	0.40	0.19	2004–2008	DWR Website 2010
Feather River at Oroville	31	0.033	0.37	0.19	2003–2008	DWR Website 2010
Feather River at Oroville[a]	30	0.052	0.28	0.16	2003–2008	DWR Website 2010
Selenium Concentrations for Inflows to the Delta						
Sacramento River at Verona	24	0.061	0.39	0.21	2003–2009	DWR Website 2010
Sacramento River at Verona[a]	21	0.15	0.29	0.20	2004–2009	DWR Website 2010
Sacramento River at Knights Landing	13	0.19	1.0	0.45	2003, 2004, 2007, 2008	DWR Website 2009
Sacramento River at Freeport[a]	62	0.044	1.0	0.32	1996–2001, 2007–2010	USGS Website 2010
San Joaquin River at Vernalis (Airport Way)[c]	105d	0.20	2.3	0.83	1999–2007	Bureau of Reclamation 2009d
San Joaquin River at Vernalis (Airport Way)	201	0.40	2.8	0.98	1999–2002	BDAT Website 2009
San Joaquin River at Vernalis (Airport Way)[c]	453	0.40	2.8	0.84	1999–2007	SWAMP 2009
Selenium Concentrations within/near the Delta						
North: Cache Slough near Ryer Island Ferry	7	0.05	0.24	0.12	1999–2000	BDAT Website 2009
South: Old River at Tracy Boulevard	1	0.61	0.61	0.61	2002	BDAT Website 2009
South: Old/Middle River	6	1.0	1.0	1.0	1999	DWR Website 2009
South: Old/Middle River[a]	6	1.0	2.0	1.6	1999	DWR Website 2009
Central-West: Sacramento River near Mallard Island (BG20)	11	0.06	0.45	0.11	2000–2008	SFEI Website 2010
Central-West: Sacramento River near Mallard Island (BG20)[a]	12	0.03	0.44	0.09	2000–2008	SFEI Website 2010
Central-West: San Joaquin River near Mallard Island (BG30)	11	0.03	0.40	0.11	2000–2008	SFEI Website 2010
Central-West: San Joaquin River near Mallard Island (BG30)[a]	11	0.03	0.45	0.09	2000–2008	SFEI Website 2010

Site	No. of Samples	Selenium Concentration (μg/L) Min.	Max.	Mean	Years	Source
Suisun Bay	38	0.02	0.21	0.12	2000–2008	SFEI Website 2010
Suisun Bay[a]	38	0.02	0.44	0.10	2000–2008	SFEI Website 2010
Selenium Concentrations for the Delta's Major Outputs						
Banks Pumping Plant[a]	71	1.0	2.0	1.0	2001–2007	MWQI 2003, 2005, 2006, 2008

Sources: BDAT Website 2009; DWR Website 2009, 2010; MWQI 2003, 2005, 2006, 2008; Bureau of Reclamation 2009d; SFEI Website 2010; SWAMP 2009; USGS Website 2010.

Notes: Data include detected concentrations and reporting limits for undetected concentrations. Means are geometric means.

Max. = maximum; μg/L = micrograms per liter; Min. = minimum

[a] Dissolved selenium concentration

[b] Includes data collected from Colusa Basin Drain near Knights Landing and Sacramento River below Knights Landing

[c] Not specified whether total or dissolved selenium

[d] Represents the number of months with an average concentration of selenium, not total samples collected

Table 8-24. Selenium Concentrations in Surface Water Reported by CALFED Bay-Delta Program

Site	No. of Samples	Dissolved Selenium (µg/L)			Particulate Selenium (µg/L)			Total Selenium (µg/L)		
		Min.	Max.	Mean	Min.	Max.	Mean	Min.	Max.	Mean
San Joaquin River at Stockton	5[a]	0.52	1.01	0.73	0.005	0.04	0.02	0.55	1.03	0.76
Calaveras River	2[a]	0.55	0.72	0.63	0.005	0.03	0.01	0.56	0.75	0.65
Fourteen Mile Slough	6[a]	0.35	0.94	0.59	0.01	0.03	0.01	0.36	0.95	0.61
McDonald-Empire	5[a]	0.09	0.91	0.17	0.005	0.03	0.01	0.10	0.94	0.18
Mildred Island South	1[a]	0.12	0.12	0.12	0.02	0.02	0.02	0.14	0.14	0.14
Mildred Island Center	1[a]	0.11	0.11	0.11	0.01	0.01	0.01	0.13	0.13	0.13
Mildred Island North	1[a]	0.09	0.09	0.09	0.01	0.01	0.01	0.10	0.10	0.10
Venice	1[a]	0.12	0.12	0.12	0.01	0.01	0.01	0.12	0.12	0.12
Franks Tract South	1	0.10	0.10	0.10	0.00	0.00	0.00	0.10	0.10	0.10
Franks Tract East	1	0.10	0.10	0.10	0.002	0.002	0.002	0.10	0.10	0.10
Franks Tract West	1[a]	0.12	0.12	0.12	0.01	0.01	0.01	0.14	0.14	0.14
Mokelumne River	6[a]	0.09	0.22	0.13	0.01	0.01	0.01	0.10	0.23	0.14
Three Mile Slough	6[a]	0.09	0.13	0.11	0.01	0.02	0.01	0.10	0.15	0.13
Sacramento River at Rio Vista	4	0.10	0.14	0.12	0.01	0.01	0.01	0.11	0.15	0.13
Antioch	5	0.08	0.17	0.12	0.01	0.03	0.02	0.10	0.19	0.14
Pittsburg East	2	0.07	0.15	0.10	0.01	0.01	0.01	0.08	0.16	0.11
Pittsburg West	2	0.11	0.12	0.11	0.02	0.03	0.02	0.13	0.14	0.14
Suisun East	2	0.10	0.14	0.12	0.01	0.01	0.01	0.11	0.15	0.13
Suisun Center	2	0.12	0.14	0.13	0.02	0.02	0.02	0.14	0.15	0.15
Suisun West	3	0.13	0.19	0.15	0.01	0.05	0.02	0.15	0.23	0.17
Grizzly Bay East	1	0.12	0.12	0.12	0.02	0.02	0.02	0.14	0.14	0.14
Grizzly Bay Center	3	0.10	0.17	0.13	0.010	0.017	0.013	0.11	0.18	0.14
Grizzly Bay West	1	0.16	0.16	0.16	0.011	0.011	0.011	0.17	0.17	0.17
Benicia	4	0.11	0.16	0.14	0.01	0.02	0.02	0.13	0.18	0.16

Source: Lucas and Stewart 2007.
Notes: Data collected within 1 mile of sample stations were compiled in the same data location. Means are geometric means.
Max. = maximum, µg/L = micrograms per liter , Min. = minimum
[a] One sample each station was collected during July 2000; all other data are from January 2003 to January 2004.

Sporadic sampling has been conducted at a few locations in the Delta (Tables 8-26 and 8-27). The only two locations at which sampling was conducted over several recent years are in the Sacramento and San Joaquin Rivers near Mallard Island (near the western limit of the Delta). Observed total selenium concentrations at these stations are considered more representative of generalized Delta concentrations than of the individual rivers (Tetra Tech 2008). Total and dissolved selenium concentrations were somewhat lower at those locations during low flow in a dry year (<0.1 μg/L in August 2001) than during high flow (>0.1 μg/L in February 2001) (Tetra Tech 2008). Cutter and Cutter (2004) reported similar flow-related patterns for those locations. The maximum selenium concentration found in the Delta was 2 μg/L at an Old/Middle River location in the south subarea of the Delta. Except for that location, the available data show mean concentrations well below 1 μg/L.

As noted in Table 8-23, inflow originating from the San Joaquin River has selenium concentrations several times higher than those from the Sacramento River, but flows in the San Joaquin River at Vernalis are usually only about 10–15% of the inflow from the Sacramento River at Freeport (Tetra Tech 2008). Therefore, on an annual basis, selenium loads from both rivers to the Delta are large, but selenium processes in the Delta are not well characterized. Besides the normal processes of settling and mixing, a large portion of the water in the Delta is exported for agricultural and urban uses in other parts of California. The relative contribution of the Sacramento and San Joaquin Rivers to the overall outflow from the Delta to the North Bay changes with tidal cycles and season. The contribution from the San Joaquin River can potentially increase during the drier months of September through November (Presser and Luoma 2006; Tetra Tech 2008).

Regulatory criteria with respect to selenium are as follows. A TMDL for selenium in the San Joaquin River was completed by the Central Valley Water Board and approved by USEPA in March 2002. The TMDL is implemented through: (1) prohibitions of discharge of agricultural subsurface drainage water adopted in a Basin Plan Amendment for the Control of Subsurface Drainage Discharges (State Water Board Resolution 96-078), with an effective date of January, 10 1997; and (2) load allocations in waste discharge requirements (Central Valley Regional Water Quality Control Board 2009d). As mentioned above, the Central Valley Water Board adopted a Basin Plan amendment in May 2010 to modify the compliance time schedule for regulated discharges to Mud Slough (north), which is a tributary to the San Joaquin River.

The water quality objective for the lower San Joaquin River at Vernalis is 5μg/L as a 4-day average for above normal and wet water year types, and 5μg/L as a monthly mean for dry and below normal water year types (Central Valley Regional Water Quality Control Board 2001, 2007). Selenium criteria were promulgated for all San Francisco Bay and Delta waters in the National Toxics Rule (NTR) (San Francisco Bay Regional Water Quality Control Board 2007). The NTR criteria specifically apply to San Francisco Bay upstream to and including Suisun Bay and the Delta. The NTR values are 5.0 μg/L (4-day average) and 20 μg/L (1-hour average). By comparison, the available data show that the maximum concentration at Vernalis has not exceeded 3 μg/L since implementation of the Grassland Bypass Project, and the mean is less than 1 μg/L for the period from 1999 through 2007. The CTR criteria for aquatic life protection in saltwater are substantially higher than the freshwater criteria (i.e., chronic = 71 μg/L; acute = 290 μg/L).

Selenium concentrations in water exported from the Delta via Banks pumping plant ranged from 1 to 2 μg/L, with a mean of 1.02 μg/L for 2003–2007. Drinking water standards for selenium are average concentrations of 50 μg/L, both as the MCL—the enforceable standard that defines the highest concentration of a contaminant allowed in drinking water—and the maximum contaminant level goal (MCLG)—a nonenforceable health goal set at a level at which no known or anticipated adverse effect to human health would result, while allowing an adequate margin of safety (U.S. Environmental Protection Agency Website 2009a). On April 2, 2010, the Office of Environmental Health Hazard Assessment (OEHHA) proposed establishing a public health goal of 30 µg/L in drinking water, based on data from adverse effects of selenium in a human population, with a 45-day comment period (Office of Environmental Health Hazard Assessment 2010). Public health goals are developed for use by DPH in establishing primary drinking water standards (state MCLs). All concentrations that have been measured in the Delta, or in tributary streams immediately upgradient of the Delta, as well as those at Banks pumping plant and in the California Aqueduct, are less than 10% of the MCL and the MCLG (Table 8-23 and Table 8-24).

Sediment and Fish Tissue Concentrations

Very little information is available for selenium concentrations in sediment or biota from in the Delta (Table 8-25, Table 8-26, and Table 8-27) that would be useful for evaluating risks for fish, wildlife, or the people consuming them. Selenium concentrations in sediment usually are not closely related to effects on fish or wildlife resources, although screening-level values such as those provided by DOI are sometimes used for comparison to background or potential effect levels (DOI 1998). Background selenium concentrations in selenium-normal freshwater environments are typically <1 mg/kg dry weight. Consequently, the concentrations reported for the Sacramento and San Joaquin Rivers near Mallard Island and in Suisun Bay (Table 8-26) are consistent with background levels. They are well below the concentrations associated with effects on fish and bird populations (2.5 mg/kg). Selenium analyses of clams from the Mallard Island locations are consistent with other bivalves in the Bay-Delta (Linville et al. 2002; Stewart et al. 2004). Whole-body fish from the San Joaquin River near Manteca had selenium concentrations within the range of background (<1–4 mg/kg, typically <2 mg/kg), although the mean was slightly higher than typical background (Table 8-27). Selenium concentrations in delta smelt from Chipps Island also were consistent with background.

Table 8-25. Selenium Concentrations in Delta and Suisun Bay Sediment

Site	No. of Samples	Selenium Concentration (mg/kg)			Year Collected	Source
		Min.	Max.	Mean		
Central-West: Sacramento River near Mallard Island (BG20)	9	0.031	0.24	0.083	2000–2008	SFEI Website 2010
Central-West: San Joaquin River near Mallard Island (BG30)	9	0.087	0.34	0.21	2000–2008	SFEI Website 2010
Suisun Bay	69	0.016	0.58	0.17	2000–2008	SFEI Website 2010

Source: SFEI Website 2010.

Notes: Data include detected concentrations and reporting limits for nondetected concentrations. Means are geometric means.

Max. = maximum, mg/kg = milligrams per kilogram, dry weight concentration, Min. = minimum

Table 8-26. Selenium Concentrations in Biota in or near the Delta

Site	No. of Samples	Selenium Concentration (mg/kg) Min.	Max.	Mean	Common Name	Year Collected	Source
Central-West: Sacramento River near Mallard Island (BG20)	5	4.0	19	8.1	Clam	1999–2001, 2008	SFEI Website 2010
Central-West: San Joaquin River near Mallard Island (BG30)	5	4.1	26	9.1	Clam	1999–2001, 2008	SFEI Website 2010
Chipps Island[a]	41	0.70	2.3	1.5	Delta Smelt	1993, 1994	Bennett et al. 2001
San Joaquin River, Dos Reis State Park and Mossdale Sites[b]	13	1.6	3.4	2.6	Silversides	May–July 1995	Bennett et al. 2001

Sources: Bennett et al. 2001; SFEI Website 2010.
Notes: Means are geometric means.
Max. = maximum, mg/kg = milligrams per kilogram, dry weight concentration, Min. = minimum
[a] Most of the fish were collected at Chipps Island, but includes some fish ("fewer than 5") from Garcia Bend (near Sacramento).
[b] Near Manteca

Table 8-27. Selenium Concentrations in Largemouth Bass

Site	No. of Samples	Selenium Concentrations in Fish Fillets (mg/kg, wet weight) Min.	Max.	Mean	Selenium Concentrations in Whole Body Fish (mg/kg, dry weight) Min.	Max.	Mean	Years
Sacramento River at Veterans Bridge	3	0.40	0.81	0.56	1.7	2.9	2.2	2005
Sacramento River at River Mile 44[a]	9	0.27	0.72	0.46	1.2	2.7	1.9	2000, 2005, 2007
Sacramento River near Rio Vista	9	0.30	0.80	0.44	1.3	3.2	1.9	2000, 2005, 2007
San Joaquin River at Vernalis	8	0.15	0.63	0.40	0.77	2.5	1.7	2000, 2005, 2007
Old River near Tracy	3	0.45	0.69	0.55	2.0	2.9	2.4	2005
San Joaquin River at Potato Slough	9	0.22	0.89	0.38	1.1	3.5	1.6	2000, 2005, 2007
Middle River at Bullfrog	6	0.37	0.58	0.47	1.6	2.3	2.0	2005, 2007
Franks Tract	8	0.15	0.70	0.37	0.79	3.0	1.7	2000, 2005, 2007
Big Break	9	0.15	0.82	0.38	0.81	3.1	1.6	2000, 2005, 2007
Discovery Bay	3	0.32	0.41	0.37	1.5	1.7	1.6	2005
Whiskey Slough	2	0.35	0.47	0.41	1.6	1.9	1.7	2005

Source: Foe 2010.
Notes: Means are geometric means.
Max. = maximum, mg/kg = milligrams per kilogram, Min. = minimum
[a] Near Clarksburg

A large number of fish tissue samples were collected from the Sacramento and San Joaquin River watersheds and the Delta between 2000 and 2007 for mercury analysis. As part of the Strategic Workplan for Activities in the San Francisco Bay/Sacramento–San Joaquin Delta Estuary (Water Boards 2008), archived largemouth bass samples were analyzed for selenium to determine the primary source of the selenium being bioaccumulated in bass in the Delta and whether selenium concentrations in bass were above recommended criteria for the protection of human and wildlife health (Foe 2010). Results of this study are the most relevant biota data from the Delta, and they are summarized in Table 8-27.

There were no differences in selenium concentrations in largemouth bass caught in the Sacramento River between Veterans Bridge and Rio Vista in 2005, and there was no difference in selenium concentration on the San Joaquin River between Fremont Ford (not shown in Table 8-27) and Vernalis (Foe 2010). Also, there was no difference in bass selenium concentrations in the Sacramento River at Rio Vista and in the San Joaquin River at Vernalis in 2000, 2005, and 2007. The lack of a difference in bioavailable selenium between the two river systems was unexpected, because the San Joaquin River is considered a significant source of selenium to the Delta. Selenium concentrations were unexpectedly higher in both river systems in 2007 than in other years, and the reasons for this difference are unknown.

The Central Valley appeared to be the dominant source of bioavailable selenium to bass in the Delta, because tissue concentrations generally decreased seaward (Foe 2010). Selenium concentrations in bass were highest in a dry water year type (2007), consistent with predictions of the Presser and Luoma (2006) bioaccumulation model.

Selenium concentrations in the bass were compared to criteria recommended for the protection of human health (based on fillets; 2 mg/kg, wet weight) and wildlife health (based on whole-body fish; "concern threshold" of 4–9 mg/kg, dry weight) (Foe 2010). Average and maximum concentrations were always less than the criteria.

Selenium concentrations in the livers of 2 out of 86 Sacramento splittail collected from Big Break, Nurse Slough, and Sherman Island exceeded the concentration (>27 mg/kg; Teh et al. 2004) at which growth, survival, and histopathology effects were observed in long-term laboratory studies of juvenile splittail (Greenfield et al. 2008). Mean selenium concentrations ranged from 11.8 to 16.3 mg/kg in 2001 and from 8.36 to 8.84 mg/kg in 2002, with the highest mean concentrations occurring in fish from Nurse Slough (in Suisun Marsh). Other field and laboratory studies have been conducted with splittail (Deng et al. 2007, 2008) and with white sturgeon (Tashjian and Hung 2006; Tashjian et al. 2006, 2007) or other fish (Linville et al. 2002; Stewart et al. 2004), but no other analytical data for field-collected fish from in the Delta were found.

Species to be considered for linkage of waterborne or food-web selenium to fish and birds will include those identified by the U.S. Fish and Wildlife Service (USFWS) as being at risk from selenium exposure in the San Francisco estuary, insofar as possible (U.S. Fish and Wildlife Service 2008). However, species-specific and Delta-specific bioaccumulation and trophic transfer factors are not available, so assessment will be qualitative.

Current ambient water quality criteria are based on waterborne selenium concentrations, but USEPA published a draft ambient water quality criterion for selenium in 2004 that was based on selenium concentrations in whole-body fish (U.S. Environmental Protection Agency Website 2009b; State Water Resources Control Board 2010b). The recommendations were intended to protect aquatic life under the CWA. They incorporated the latest scientific information available to the agency at that time and reflect an improved approach to measuring this bioaccumulative pollutant in the aquatic environment. In October 2008, USEPA released a technical report describing the results from additional testing of the toxicity of selenium to juvenile bluegill sunfish under winter temperature conditions, and also provided references for data obtained since 2004 (U.S. Environmental Protection Agency 2008b).

Recent preliminary information concerning USEPA's pending revision of the draft chronic ambient water quality criterion suggests that the agency will propose a two-part criterion: selenium concentration in fish egg/ovary coupled with a water screening value (Delos pers. comm.). If the latter is exceeded, the former must be either measured or may be estimated using whole-body concentrations. It is expected the water screening value will be conservative (so that if the value is not exceeded, there will be no problem), and that it will be lower than the current 5 μg/L USEPA water criterion. The number for egg/ovary selenium will be driven by the available trout, bluegill, and largemouth bass studies. EC_{10} values (concentration at which 10% of offspring are affected) for those species range from about 18 to 23 mg/kg dry weight based on egg/ovary data. Consistent with USEPA's criterion calculation methodology, the egg/ovary criterion is likely to be extrapolated downward from the lowest observed value and is, thus, expected to be in the range of 15 to 18 mg/kg.

8.1.3.11 Other Trace Metals

Background

Trace metals occur naturally in the environment, and can be toxic to human and aquatic life in high concentrations. Trace metals include aluminum (Al), arsenic (As), cadmium (Cd), copper (Cu), lead (Pb), nickel (Ni), silver (Ag), and zinc (Zn). The beneficial uses of Delta waters most affected by trace metal concentrations include aquatic life uses (cold freshwater habitat, warm freshwater habitat, and estuarine habitat), harvesting activities that depend on aquatic life (shellfish harvesting, commercial and sport fishing), and drinking water supplies (municipal and domestic supply) (Table 8-1). Metals that may pose a problem in the project area regarding water quality are briefly described below.

Aluminum

Aluminum is a common element in mineral soils, and the concentration of total aluminum in water bodies is elevated above background levels during watershed runoff events that transport high-suspended sediment loads. Generally, a large majority of total aluminum is not bioavailable. Bioavailable aluminum has toxic effects on aquatic biota. For example, when waters become acidic, aluminum can disassociate and exist as a toxic ion. Hence, the receptor of concern for aluminum is aquatic life, similar to many of the other trace metals. Limited data (from the Banks and Barker Slough pumping plants) indicates no violations of the MCLs during water years 2001–2006.

Arsenic

Arsenic is a semi-metal element that is tasteless and odorless and highly toxic to humans. Long-term, chronic exposure to arsenic has been linked to cancer of the bladder, lungs, skin, kidneys, nasal passages, liver, and prostate (U.S. Environmental Protection Agency Website 2009c). Short-term exposure to high doses of arsenic can cause acute symptoms such as skin damage, circulatory system dysfunction, stomach pain, nausea and vomiting, diarrhea, numbness in hands and feet, partial paralysis, and blindness (U.S. Environmental Protection Agency Website 2009c).

Sources of arsenic contamination in water supplies include erosion of natural deposits, agricultural runoff, and runoff or wastewater from industrial point sources. Arsenic is commonly found in volcanic rocks and metal oxides, and is commonly associated with sulfide minerals and organic carbon (Saracino-Kirby 2000). Arsenic is also found in certain pesticides, fertilizers, and feed additives used in commercial agricultural operations (Saracino-Kirby 2000; U.S. Environmental Protection Agency Website 2009c). Approximately 90% of the industrial arsenic used in the United States is used as wood preservative; industry practices such as copper smelting, mining, and coal burning also contribute arsenic to the environment (U.S. Environmental Protection Agency Website 2009c).

High concentrations of arsenic tend to be found more commonly in groundwater than in surface water bodies, and high concentrations in water bodies occur more frequently in the western United States than in other parts of the country (Saracino-Kirby 2000; U.S. Environmental Protection Agency Website 2009c).

Cadmium

Cadmium can also be toxic to humans. Long-term, chronic exposure to cadmium has been linked to blood damage and several forms of cancers; short-term exposure to high concentrations of cadmium may cause nausea, vomiting, diarrhea, muscle cramps, salivation, sensory disturbances, liver injury, convulsions, shock, and renal failure (U.S. Environmental Protection Agency Website 2009d). Some aquatic species (e.g., Chinook salmon, Sacramento sucker, threespine stickleback) tend to bioaccumulate cadmium, while others do not (U.S. Environmental Protection Agency Website 2009d; Saiki et al. 1995). The toxicity of cadmium to aquatic life varies with the total hardness of the water, exhbiting generally lower toxicity as hardness increases.

Cadmium occurs naturally in zinc, lead, copper, and other ores, which may erode and release cadmium into water bodies, especially in soft, acidic waters (U.S. Environmental Protection Agency Website 2009d). Cadmium is used in a variety of industrial activities and applications, including metal plating and coating operations, machinery and baking enamels, photography, and nickel-cadmium and solar batteries (U.S. Environmental Protection Agency Website 2009d). Approximately 9 million pounds of industrial cadmium were produced or imported in the United States in 1986 (U.S. Environmental Protection Agency Website 2009d). Cadmium can enter water bodies through urban or industrial wastewater, leaching from landfills, and from corrosion of some galvanized plumbing and water mains (Van Geen and Luoma 1999a; U.S. Environmental Protection Agency Website 2009d).

Regulation of industrial and urban wastewater has led to a steady reduction in metal discharges to water bodies over the past two decades; however, these contaminants persist in sediments (Van Geen and Luoma 1999a). A study of cadmium concentrations in San Francisco Bay revealed that coastal upwelling of cadmium-rich sediment contributes to seasonal peaks in those levels in the Bay. Surface samples collected throughout the Bay confirmed an internal cadmium source unrelated to river discharge (Van Geen and Luoma 1999a). The results of the study suggested that concentrations of cadmium and other metals in the Delta and Bay water column are sensitive to river inflow, and may have increased in response to reduced inflows in recent years (Van Geen and Luoma 1999a).

Copper

Copper is found primarily in the form of ores with other elements. Copper occurs in both organic and inorganic forms; organic copper is an essential micronutrient for animals, while exposure to high concentrations of inorganic copper can be toxic (Buck et al. 2006; U.S. Environmental Protection Agency Website 2009e). In humans, short-term exposure to copper can cause nausea and vomiting; long-term exposure can cause liver or kidney damage (U.S. Environmental Protection Agency Website 2009e). Copper toxicity to aquatic life also is dependent on the water hardness.

Sources of copper contamination include natural deposits, industrial and urban wastewater, and urban stormwater runoff (Buck et al. 2006; U.S. Environmental Protection Agency Website 2009e). Historical copper contamination from industrial development and mining operations persists in sediments in the Delta and Bay (Buck et al. 2006). Dissolved copper tends to bind with organic matter, resulting in a strong correlation between concentrations of dissolved copper and organic carbon (Buck et al. 2006). This binding of copper with organic carbon has reduced concentrations of the toxic form of copper in San Francisco Bay to concentrations that do not pose a threat to aquatic life; without the copper-binding organic matter, it is likely that copper concentrations in the Bay would be toxic to most aquatic microorganisms (Buck et al. 2006).

The most common source of copper contamination in drinking water is corrosion of household copper plumbing materials (U.S. Environmental Protection Agency Website 2009e). This contamination cannot be directly detected or removed with conventional drinking water treatment methods; thus, USEPA requires drinking water suppliers to control the corrosiveness of their water to minimize copper contamination at the tap (U.S. Environmental Protection Agency Website 2009e).

Lead

Lead is a metal found in natural deposits as ores with other elements. Short-term exposure to lead can cause a variety of health effects, including problems with blood chemistry, mental and physical development in babies and young children, and increases in blood pressure in some adults (U.S. Environmental Protection Agency Website 2009f). Long-term exposure to lead has the potential to cause stroke, kidney disease, and cancer (U.S. Environmental Protection Agency Website 2009f). Lead toxicity to aquatic life also is dependent on the water hardness.

Sources of lead contamination include natural deposits, mining, and smelting operations (U.S. Environmental Protection Agency Website 2009f). Lead is sometimes used in household plumbing materials or in water distribution systems. Lead is also regulated in drinking water systems via the USEPA's Lead and Copper rule.

Nickel

Recent work has shown that the most substantial sources of nickel are in the South Bay, the next largest source is in the Delta (Yee et al. 2007). Nickel sources in the region originate from natural and human sources such as natural rock erosion, urban runoff, and wastewater treatment plants (Yee at al. 2007). Total nickel concentrations from samples in the Delta averaged 3.5 μg/L in the dry season, and 5.1 μg/L in the wet season. Davis et al. (2000) estimated nickel loads were 975,000 kg/yr from San Francisco Bay bottom sediments, 410,000 kg/yr from the Delta, 49,000 kg/yr from Bay tributaries, 4,800 kg/yr from effluent, and 580 kg/yr from atmospheric deposition.

Silver

Silver is present in San Francisco Bay sediments, which can have toxic effects on biota (Flegal et al. 2007). Silver toxicity to aquatic life also is dependent on the water hardness. Most fluxes of silver in the Bay are from past industrial activities and wastewater treatment sources. Delta waters entering the Bay have some of the lowest river silver concentrations reported.

Zinc

Zinc can potentially have toxic effects on biota, although it is an essential element in the diet of these plants and animals. Zinc is used to make tires, so it is generally found at higher concentrations near highways. It is also used in manufacturing processes.

Importance in the Project Area

Trace metal contamination demonstrates the magnitude of effect that human activities have had on the Delta. Sediment transport to the Bay increased by nearly an order of magnitude during the mid-1800s to early 1900s as a result of hydraulic gold mining operations; these sediments carried high concentrations of metal contaminants, which persist today (Van Geen and Luoma 1999b). The effect of these residual metals in the water column is exacerbated by the decreased river inflows into the Delta in recent years, as well as the continued discharge of contaminants from stormwater runoff and other urban activities.

Hayward et al. (1996), in an evaluation of metals concentrations in the San Joaquin River, found that concentrations of trace metals were uniformly low, with a few isolated exceptions related to specific point sources (e.g., elevated zinc near boat docks in the Stockton Harbor). However, relatively low concentrations in water can have effects on aquatic life. A 2006 study of sediment toxicity in the San Francisco estuary identified *toxic hotspots* where metals were found to cause sediment toxicity in bivalve embryos (Anderson et al. 2007).

Alpers et al. (2000:2) evaluated metals concentrations in the Sacramento River (Shasta Dam to Delta region) from July 1996 to June 1997, encompassing both low flow and flood conditions. Their study showed that cadmium, copper, and zinc were transported primarily in dissolved form upstream of major agricultural activities but primarily in colloidal form downstream. Aluminum, iron, and lead were transported primarily in colloidal form at all mainstem Sacramento River sites.

Existing Conditions in the Project Area

In 2000, the Association of California Water Agencies conducted a study to summarize arsenic data from across the state and to assess the effect of USEPA's arsenic standard on California's drinking water programs (Saracino-Kirby 2000). Sampling data collected by USGS in 1990 and 2000, California Department of Health, DWR, Reclamation, and other sources were analyzed. The study found that the statewide average concentration of arsenic in groundwater measured between 1990 and 2000 was 9.8 µg/L, and that 22% of the 4,513 sampling stations recorded arsenic concentrations of 10 µg/L or higher during this time period (Saracino-Kirby2000) (Table 8-28). The study found no noticeable trend in arsenic concentrations through time (Saracino-Kirby 2000). Thirty percent of the state's groundwater basins were found to have average arsenic concentrations of 10 µg/L or higher at some point between 1990 and 2000 (Saracino-Kirby 2000).

The Association of California Water Agencies study also analyzed samples from 188 sampling stations on surface water bodies, and found that the statewide average concentration of arsenic in surface water between 1990 and 2000 was 42 µg/L; however, this average was influenced by a small number of data points with very high values. Nine percent of the sampling locations recorded average concentrations higher than 10 µg/L during the same time period (Saracino-Kirby 2000).

There was a large monitoring effort from 1988 to 1993 to assess metals in the Delta. The stations from this monitoring that coincide with other stations examined in this section include the San Joaquin River at Buckley Cove, Sacramento River at Hood (actually collected at Greene's Landing), Sacramento River above Point Sacramento, San Joaquin River at Antioch Ship Channel, Old River at Rancho Del Rio, Suisun Bay at Bulls Head Point near Martinez, and Franks Tract. Analysis of the monitoring results indicated that most metal median values were similar between locations, with zinc median values being the highest of all the metals. Results are shown in Table 8-28.

Recent monitoring efforts to assess these metals in the Plan Area is limited to four of the selected locations, including the Banks pumping plant, the Barker Slough Pumping Plant, the Sacramento River above Point Sacramento, and the San Joaquin River at Antioch Ship Channel (Table 8-29). The latter two stations were sampled for metals on an annual basis by SFEI as part of its air monitoring program (denoted as stations BG20 and BG30, respectively). The SFEI laboratory reporting limits are about 1,000 times more sensitive than the laboratory reporting limits for the Banks and Barker Slough pumping plants.

Analytes examined in the present effort for the Banks and Barker Slough pumping plants include aluminum, arsenic, cadmium, copper, lead, nickel, silver, and zinc. The monitoring program sampled for each of these analytes approximately 72 times during the water years 2001 to 2006 for each location; detections are presented in Table 8-29.

Aluminum detections for the Barker Slough Pumping Plant occurred each year between December and May (wet season), with the maximum noted in May 2001. Arsenic, copper, and nickel were detected for almost all sampling events for each location. Median values for these metals were similar at the two locations. Elevated values for these metals occurred primarily between January and March, although the copper maxima occurred during May, all representing the wet season.

There was one detection for aluminum, one detection for lead, and three detections for zinc at the Banks pumping plant. There were no detections for cadmium or silver at either station, and no detections for lead or zinc at the Barker Slough Pumping Plant. As mentioned previously, laboratory detection limits for the SFEI laboratory are very low, enabling the detection of many metals examined in the current study, as indicated in Table 8-30.

Cadmium values matched the MCL of 0.005 mg/L at several locations during the 1988–1993 study, but there were no detections at either the Banks or Barker Slough pumping plants during water years 2001–2006.

The samples were taken between late July and late August, which does not allow examination of wet versus dry season results. The samples indicate that all selected metals are still present in the Sacramento and San Joaquin River outflows during summer conditions, albeit at low concentrations. Values for all metals were comparable for the two locations. For both locations, copper, nickel, and zinc occurred at higher concentrations than the other metals.

Monitoring efforts in the north and south of Delta areas (water years 2001–2006) indicate that mean values for metals at the Feather River at Oroville tended to be lower than those for the Sacramento River sites, with the exception of cadmium and silver (Table 8-31). Mean values for the north of Delta area were all 0.02 mg/L. South of Delta mean values (arsenic, copper, nickel) appear higher than north of Delta stations examined; however, the analytical sensitivity was greater for the north of Delta stations.

Regulatory criteria with respect to trace metals are as follows. CTR criteria exist for all examined metals in this study (except aluminum). CTR chronic and acute criteria for aquatic life protection in freshwater are hardness dependent and expressed on a dissolved basis; the CTR saltwater aquatic life criteria are not hardness dependent. Depending on the hardness and specific metal, either the freshwater or saltwater criteria may be lower than the other. The Central Valley Water Board Basin Plan values exist for arsenic, copper, silver, and zinc; no exceedances were noted. The San Francisco Bay Regional Water Board Basin Plan values exist for all metals in this study except silver; no exceedances were noted. California drinking water MCLs exist for all metals in this study; no exceedances were noted.

Regarding the Basin Plan narrative objectives, any of these metals might be considered *toxic* at high concentrations.

- **Aluminum** – Aluminum has a 200 µg/L secondary drinking water standard MCL for California, and the primary MCL is 1,000 µg/L. The San Francisco Bay Regional Water Board Basin Plan limits the metal to 20 mg/L aluminum for agricultural supply – irrigation, and 5 mg/L aluminum for agricultural supply – livestock watering. Neither the CTR nor Basin Plans include criteria/objectives for aluminum. Central Valley Water Board evaluates aluminum under its narrative toxicity objective. Water Board staff use the USEPA National Recommended Water Quality Criteria for aluminum (EPA-440/5-86-008, August 1988) to numerically interpret the narrative objective. The USEPA recommended aquatic life criterion for typical hardness (>10 mg/L) and pH (>6.8) conditions is 750 µg/L, expressed in the total recoverable form.
- **Arsenic** – The MCL for arsenic in drinking water is 10 parts per billion (ppb) (U.S. Environmental Protection Agency Website 2009c). The MCLG for drinking water is 0 ppb.
- **Cadmium** – The MCL for cadmium in drinking water is 5 µg/L (U.S. Environmental Protection Agency Website 2009d). Applicable freshwater aquatic life criteria for cadmium are lower, and saltwater criteria are higher, than the drinking water MCL.
- **Copper** – The MCLG for copper is 1,300 µg/L (U.S. Environmental Protection Agency Website 2009e). Applicable freshwater and saltwater aquatic life criteria for copper are substantially lower than the MCL, and the Central Valley Water Board Basin Plan objective for aquatic life protection is 10 µg/L. Applicable CTR freshwater and saltwater aquatic life criteria for copper are generally lower than the MCL (except the saltwater acute criterion).
- **Lead** – The MCLG for lead is 0 µg/L. USEPA regulates corrosiveness of water to minimize lead contamination of public drinking water at the tap (U.S. Environmental Protection Agency Website 2009f). The concentration at which drinking water must be regulated for lead is 15 µg/L (U.S. Environmental Protection Agency Website 2009f).
- **Nickel** – Nickel is listed on the Section 303(d) list for the San Francisco Bay, with the source of contamination unknown. However, the San Francisco Bay Regional Water Board recommended delisting nickel because the water quality standard is being met. The California primary MCL for nickel is 100 µg/L. Applicable freshwater and saltwater aquatic life criteria for nickel are generally lower than the MCL (except the freshwater acute criterion).
- **Zinc** – Applicable freshwater and saltwater aquatic life criteria for zinc (i.e., about 80–120 µg/L at moderate hardness) are considerably lower than the secondary MCL of 5,000 µg/L.

Table 8-28. Median Metal Concentrations for Selected Sites, May 1988–September 1993

Location	Arsenic Dissolved (µg/L)	Arsenic Total (µg/L)	Cadmium Dissolved (µg/L)	Cadmium Total (µg/L)	Copper Dissolved (µg/L)	Copper Total (µg/L)	Lead Dissolved (µg/L)	Lead Total (µg/L)	Zinc Dissolved (µg/L)	Zinc Total (µg/L)
San Joaquin River at Buckley Cove	3	3	5	5	5	5	5	5	6	10
Sacramento River at Green's Landing	2	2	5	5	5	5	5	5	6	8
Sacramento River above Point Sacramento	2	3	5	5	5	7	5	5	5	10
San Joaquin River at Antioch Ship Channel	2	2	5	5	5	6	5	5	5	11
Old River at Rancho Del Rio	2	2	5	5	5	5	5	5	5	8
Suisun Bay at Bulls Head Point near Martinez	2	3	5	5	5	7	5	5	6	15
Franks Tract	2	2	5	5	5	5	5	5	5	7
San Joaquin River at Vernalis	—	—	—	—	—	—	—	—	10	—

Source: BDAT 2009

Notes: Units are in micrograms per liter. Sample sizes are 10 to 12 (exception: San Joaquin River at Vernalis, with a sample size of 15). Sample size represents water quality samples having values at or greater than the reporting limit.

Table 8-29. Metals Concentrations at the Harvey O. Banks and Barker Slough Pumping Plants, Water Years 2001–2006

	Harvey O. Banks Pumping Plant (µg/L)					Barker Slough Pumping Plant (µg/L)				
Metal	Samples	Minimum	Maximum	Mean	Median	Samples	Minimum	Maximum	Mean	Median
Aluminum	one detection: 40 µg/L (5/16/01)					10	10	44	17	12
Arsenic	71	1	3	2	2	72	1	5	2	2
Cadmium	no detections					no detections				
Copper	71	1	9	2	2	72	1	8	3	2
Lead	one detection: 7 µg/L (11/19/03)					no detections				
Nickel	67	1	2	1	1	72	1	7	2	2
Silver	no detections					no detections				
Zinc	15 µg/L (1/16/02), 5 µg/L (9/17/03), 6 µg/L (10/15/03)					no detections				

Source: BDAT 2009.

Notes: Metals measured as dissolved. All units are in micrograms per liter (µg/L). Sample size represents water quality samples having values at or greater than the reporting limit.

Table 8-30. Metals Concentrations at the Mouths of the Sacramento and San Joaquin Rivers, Water Years 2001–2006

		Sacramento River above Point Sacramento (μg/L)					San Joaquin River at Antioch Ship Channel (μg/L)				
Metal	Fraction	Samples	Minimum	Maximum	Mean	Median	Samples	Minimum	Maximum	Mean	Median
Arsenic	Dissolved	8	0.800	2.270	1.729	1.758	7	1.190	2.310	1.861	1.900
Arsenic	Total	8	0.800	2.420	2.039	2.253	7	1.250	2.500	2.014	2.130
Cadmium	Dissolved	7	0.007	0.016	0.011	0.010	7	0.006	0.015	0.010	0.011
Cadmium	Total	7	0.015	0.032	0.027	0.026	6	0.013	0.033	0.022	0.020
Copper	Dissolved	8	1.253	3.539	1.738	1.468	7	1.410	1.888	1.654	1.606
Copper	Total	8	2.534	4.613	3.418	3.257	7	2.435	4.811	3.028	2.729
Lead	Dissolved	8	0.019	0.091	0.043	0.034	7	0.017	0.196	0.055	0.027
Lead	Total	8	0.427	1.035	0.663	0.580	7	0.263	0.950	0.530	0.445
Nickel	Dissolved	8	0.766	2.641	1.218	1.006	7	0.727	1.470	1.059	0.975
Nickel	Total	8	2.410	6.503	3.970	3.933	7	2.034	6.726	3.157	2.523
Silver	Dissolved	4	0.001	0.002	0.001	0.001	5	0	0.001	0.001	0.001
Silver	Total	7	0.001	0.009	0.004	0.003	5	0.001	0.005	0.002	0.002
Zinc	Dissolved	8	0.160	1.410	0.711	0.595	7	0.253	1.818	0.712	0.510
Zinc	Total	8	2.283	7.022	4.291	3.924	7	1.983	7.055	3.321	2.705

Source: San Francisco Estuary Institute Website 2010 (Cruise Data).

Note: All units in micrograms per liter. Sample size represents water quality samples having values at or greater than the reporting limit.

Table 8-31. Metals Concentrations at Selected North and South of Delta Stations, Water Years 2001–2006

	Sacramento River at Keswick (µg/L)					Sacramento River at Verona (µg/L)					Feather River at Oroville (µg/L)					Check 13 (µg/L)					Check 29 (µg/L)				
Metal	Samples	Minimum	Maximum	Mean	Median	Samples	Minimum	Maximum	Mean	Median	Samples	Minimum	Maximum	Mean	Median	Samples	Minimum	Maximum	Mean	Median	Samples	Minimum	Maximum	Mean	Median
Arsenic (d)	25	0.81	1.93	1.27	1.22	8	0.87	1.48	1.18	1.24	22	0.38	0.67	0.52	0.51	69	1	3	2	2	62	1	4	2	2
Arsenic (t)	28	0.84	1.94	1.36	1.30	11	0.92	1.91	1.29	1.20	23	0.47	0.99	0.60	0.56										
Cadmium (d)	8	0.007	0.036	0.021	0.023	1		0.009			1		0.023												
Cadmium (t)	14	0.008	0.095	0.028	0.019	2	0.010	0.020	0.010	0.010	2	0.029	0.033	0.031	0.031										
Copper (d)	25	0.49	3.18	1.40	1.06	8	0.62	4.22	1.55	1.33	22	0.42	1.54	0.70	0.61	69	1.00	5.00	2.00	2.00	81	1.00	4.00	2.00	2.00
Copper (t)	28	0.71	4.30	1.72	1.23	11	0.85	6.54	2.62	1.91	23	0.47	2.82	1.00	0.88										
Lead (d)	13	0.000	0.113	0.026	0.009	6	0.010	0.170	0.080	0.070	9	0.003	0.077	0.019	0.006										
Lead (t)	21	0.008	1.560	0.139	0.040	11	0.090	1.150	0.340	0.130	20	0.001	0.300	0.050	0.015										
Nickel (d)	25	0.49	2.49	1.39	1.32	8	0.58	2.57	1.27	1.13	22	0.40	1.38	0.89	0.88	67	1.00	3.00	1.00	1.00	79	1.00	3.00	1.00	1.00
Nickel (t)	28	0.50	2.73	1.56	1.47	11	0.99	8.94	2.80	1.71	23	0.79	1.93	1.12	1.05										
Silver (d)	1		0.015			1		0.005			2	0.020	0.030	0.030	0.030										
Silver (t)	4	0.003	0.091	0.037	0.027						3	0.020	0.070	0.040	0.040										
Zinc (d)	25	0.31	7.84	2.28	1.91	7	0.16	1.37	0.63	0.30	18	0.04	2.41	0.46	0.27						1		5.00		
Zinc (t)	28	1.02	11.90	3.44	2.38	11	0.53	8.18	2.68	1.16	23	0.13	2.66	0.79	0.48										

Source: BDAT 2009.
Notes: All units in micrograms per liter. Sample size represents water quality samples having values at or greater than the reporting limit.
d = dissolved
t = total

8.1.3.12 Pathogens

Background

The beneficial uses of Delta water that are affected by pathogens in the environment are municipal and domestic supply, water contact recreation, shellfish harvesting, and commercial and sport fishing. Of these beneficial uses, municipal and domestic supply and water contact recreation are the receptors most affected by pathogens because direct contact or ingestion affects human health, as shown in Table 8-1. Pathogens of concern include bacteria, such as *Escherichia coli* and *Campylobacter*; viruses, such as hepatitis and rotavirus; and protozoans, such as *Giardia* and *Cryptosporidium*. Sampling for bacterial and viral pathogens involves collection of data for fecal indicators, such as total coliforms or fecal coliforms, because pathogens are less abundant and, therefore, harder to detect than indicator bacteria.

Sources of pathogens include wild and domestic animals, aquatic species, urban stormwater runoff, discharge from wastewater treatment plants, and agricultural point and nonpoint sources such as confined feeding lots and runoff. Pathogens that have animal hosts can be transported from the watershed to source waters from natural lands or grazed lands and cattle operations; aquatic species such as waterfowl also contribute pathogens directly to water bodies. Stormwater runoff from urban or rural areas can contain pathogens carried in waste from domestic pets, birds, or rodents, as well as sewage spills. Once in the ambient environment, pathogens often die off, although in some instances they can survive and even reproduce in sediments. In most instances, pathogens in drinking water sources are removed by filtration or membranes, destroyed by disinfection techniques or UV light, or a combination. Infections in humans may arise from pathogens that break through into treated drinking water or from external sources such as food ingestion and ingestion of untreated water during recreation.

Water treatment processes that are focused on the removal of particulates, such as filtration and membranes, are generally effective at removing pathogens. Disinfection of bacteria pathogens can be achieved effectively through either chemical oxidation using chlorine or ozone, or through exposure to UV light. Viruses can also be removed effectively through chlorine or ozone oxidation. The treatment of protozoans is more challenging, as cysts and oocysts of protozoans cannot be fully removed by sand filtration and are resistant to chemical disinfection; however, disinfection using UV light has been found to be effective (Tetra Tech 2007).

Escherichia coli

Escherichia coli is an anaerobic bacterium that lives in the gastrointestinal tract of warm-blooded animals. The presence of *E. coli* normally is beneficial to the host through the synthesis of vitamins and the suppression of harmful bacteria. However, some strains of *E. coli* are pathogenic. Pathogenic *E. coli* affect humans by generating toxins that can result in diarrhea, inflammation, fever, and bacillary dysentery (U.S. Environmental Protection Agency Website 2009g). Certain strains of *E. coli* can be severely toxic to some patients, particularly children, causing hemolytic uremic syndrome and leading to destruction of red blood cells and occasional kidney failure (Tetra Tech 2007). The presence of *E. coli* is an indicator of fecal contamination, either by human waste, wastewater, or animal wastes.

Campylobacter

Campylobacter is a bacterium that can be found in natural waters throughout the year. *Campylobacter jejuni* is commonly present in the gastrointestinal tract of cattle, pigs, and poultry and is a leading cause of bacterial gastroenteritis in the United States. *Campylobacter* infection in some rare cases may be followed by Guillain-Barre Syndrome, a form of neuromuscular paralysis. Strains of *Campylobacter* have developed resistance to antibiotics, resulting in the difficulties with clinical treatment.

Hepatitis

Hepatitis is a virus that causes liver inflammation and sometimes leads to jaundice. Hepatitis Types A and E are infectious and are transmitted through the fecal-oral route. Hepatitis A is a well-documented waterborne disease and it is widespread throughout the world.

Rotavirus

Rotaviruses are the most prevalent viruses that cause diarrhea worldwide. Rotavirus was estimated to contribute to 30 to 50% of severe diarrhea disease in humans (Tetra Tech 2007). The virus can be transmitted through fecal-oral route and via contaminated food and water.

Giardia

Giardia is a parasite found in the intestinal linings of a wide range of animals and their feces, and in contaminated water. *Giardia* can survive a wide range of temperature—from ambient temperature of fresh water to internal temperatures of animals. Among the many species of *Giardia*, *Giardia lamblia* infects humans and causes diarrhea and abdominal pain. *Giardia lamblia* has been found in wastewater and has been related to several outbreaks of waterborne disease around the world (Tetra Tech 2007).

Cryptosporidium

Cryptosporidium are single-celled, intestinal parasites that infect humans and a variety of animals. These parasites can infect epithelial cells of the intestinal wall and are excreted in feces as oocysts. *Cryptosporidium* has a wide range of hosts, including domestic and wild animals. Symptoms of cryptosporidiosis, a disease caused by ingestion of *Cryptosporidium*, include diarrhea, stomach cramps, upset stomach, and slight fever; more serious symptoms can result in weakened immune systems (U.S. Environmental Protection Agency 1999). Cryptosporidiosis is a major cause of gastrointestinal illness around the world, especially to individuals with compromised immune systems. For these people, the symptoms can be more severe or life threatening.

Importance in the Project Area

A conceptual model of pathogens and pathogen indicators was recently developed for the Central Valley Drinking Water Policy Workgroup (Tetra Tech 2007). The pathogen and indicator data compiled for the model consisted primarily of measurements of total and fecal coliforms and *E. coli*, some limited data on other species of coliforms, and even more limited data on pathogens such as *Cryptosporidium* and *Giardia*. Fecal indicator concentrations are highly variable both temporally and spatially, and can vary by orders of magnitude (Tetra Tech 2007). The variable nature of pathogen and indicator concentrations in surface waters, and the rapid die off of many of these organisms in the ambient environment, makes it very difficult to quantify the importance of different sources on a scale as large as the Central Valley, especially for coliforms that are widely present in water. A single source in close proximity to the sampling location can dominate the coliform concentrations observed at a location downstream of several thousand square miles of watershed.

Of the known sources of coliform discharges into the waters of the Central Valley, it was found that wastewater total coliform concentrations for most plants were fairly low (<1,000 most probable number per 100 milliliters [MPN/100 ml]), whereas the highest total coliform concentrations in water (>10,000 MPN/100 ml) were observed near samples influenced by urban areas (Tetra Tech 2007). In fact, the regional water boards limit publicly owned treatment works discharges to <23 MPN/100 ml in National Pollutant Discharge Elimination System (NPDES) permits, with most plants limited to <2.2 MPN/100 ml. In the San Joaquin River valley, comparably high concentrations of *E. coli* were observed for waters affected by urban environments and intensive agriculture in the San Joaquin Valley (Tetra Tech 2007). Fecal indicator data showed minimal relationships with flow rates, although most of the high concentrations were observed during the wet months of the years, possibly indicating the contribution of stormwater runoff (Tetra Tech 2007).

Existing Conditions in the Project Area

There are limited pathogen data at the locations examined, as indicated in Tetra Tech (2007), and pathogen concentrations are highly variable in time and space. Data for Cryptosporidium and Giardia along the Sacramento River showed that these parameters were often not detected, and when detected, the concentrations were generally very low (Tetra Tech 2007). The low incidence of these pathogens could be caused by the presence of natural or artificial barriers that limit transport to water, by the substantial die off of oocysts that do reach the water, as well as limitations in the analytical detection of Cryptosporidium oocysts in natural waters (Tetra Tech 2007).

Regulatory criteria with respect to pathogens are as follows. The Central Valley Regional Water Quality Control Board Basin Plan specifies water contact recreation criteria for fecal coliform bacteria to not exceed a geometric mean of 200 organism/100 ml in any 30-day period (based on a minimum of 5 samples), nor more than 10% of the total number of samples taken during any 30-day period to exceed 400 organisms/100 ml. According to Tetra Tech (2007) these criteria have been exceeded at several of the water quality locations in the present study. The Central Valley Regional Water Quality Control Board Basin Plan water quality objectives for pathogens are detailed in Appendix 8A. Data are inadequate to assess whether the sites examined in this study exceeded these standards. The federal and state drinking water MCLs for pathogens are treatment technology performance requirements that essentially require complete removal. Pathogens are listed on the 2010 Section 303(d) list for the Stockton Deep Water Ship Channel, with sources including recreational and tourism activities [nonboating] and urban runoff/storm sewers.

USEPA's surface water treatment rules require that systems using surface water, or groundwater under the direct influence of surface water, to: (1) disinfect water to destroy pathogens; and (2) filter water or meet criteria for avoiding filtration to remove pathogens, so that the following contaminants are controlled at the following levels (U.S. Environmental Protection Agency Website 2009g).

- Total coliform: no more than 5% positive samples in a month (for water systems that collect fewer than 40 routine samples per month, no more than one sample can be positive per month). Every sample that has total coliform must be analyzed for either fecal coliforms or *E. coli*. If two consecutive total coliform positive samples occur, and one is also positive for *E. coli*/fecal coliforms, the system is deemed as having an acute MCL violation.

- Viruses: 99.99% removal/inactivation.
- *Giardia lamblia*: 99.9% removal/inactivation.
- *Cryptosporidium*: 99% removal.

8.1.3.13 Pesticides and Herbicides

Background

Pesticides are found in water bodies throughout the Delta. Pesticides enter rivers, streams, and the estuary in complex mixtures, and are found in winter stormwater runoff from urban areas and irrigation return water from agricultural areas.The timing of pesticide input to Delta waters is related to application rates, when pesticides are applied to farmed land, runoff events, and other transport processes (Kuivila and Jennings 2007). Concern about pesticides is primarily associated with "nontarget" organism toxic effects—because many pesticides have been developed to "target" insect pests (e.g., neurotoxins), these pesticides also have the potential to harm other organisms, including humans. Pesticide toxicity, like all toxins, is related to the dose an organism receives. For example, a pesticide applied to a rice field in the Sacramento Valley may be diluted many times before it reaches irrigation return canals and the Sacramento River. Consequently, the beneficial uses most directly affected by pesticide concentrations include aquatic organisms (cold freshwater habitat, warm freshwater habitat, and estuarine habitat), Rare, Threatened, and/or Endangered species, harvesting activities (shellfish harvesting and commercial and sport fishing), and drinking water supplies (municipal and domestic supply) (Table 8-1).

Pesticides may be described in two general categories: current use pesticides and legacy pesticides. Current use pesticides include carbamates (e.g., carbofuran), organophosphates (e.g. chlorpyrifos, diazinon, methyl parathion, malathion), thiocarbamates (e.g., molinate, thiobencarb), and more recently pyrethroids (e.g., permethrin, cypermethrin), a class of synthetic insecticides applied in urban and agricultural areas. These chemicals have toxic effects on the nervous systems of terrestrial and aquatic life, and some are toxic to the human nervous system (California Department of Water Resources 2005a; U.S. Environmental Protection Agency 2008c). USEPA has begun to phase out certain uses of organophosphatesbecause of their potential toxicity in humans, which has led to the gradual replacement of organophosphates by pyrethroids (Werner et al. 2008).

In addition to insecticides such as organophosphates and pyrethroids, herbicides are applied throughout the watershed. Aquatic herbicides are applied to control invasive aquatic plants in irrigation canals and in the Delta (CALFED Bay-Delta Program 2008a). A recent assessment of heavily used aquatic herbicides suggests that there is limited short-term and no long-term toxicity directly attributable to their use (Siemering et al. 2008). However, acute toxicity to algae (i.e., *Selenastrum capricornutum*) also has been found in numerous studies, and attributed to the widely used agricultural organophosphate herbicide diuron (de Vlaming et al. 2005).

Legacy pesticides include primarily organochlorine pesticides such as dichlorodiphenyltrichloroethane (DDT) and "Group A Pesticides" (aldrin, dieldrin, chlordane, endrin, heptachlor, heptachlor epoxide, hexachlorocyclohexane [including lindane], endosulfan, and toxaphene). These chemicals are highly persistent in the environment. Although they were banned in the 1970s because of their health and environmental effects, the compounds and their byproducts are found throughout the Delta at elevated concentrations (CALFED Bay-Delta Program 2008a). Organochlorines are prone to accumulation in sediments, and typically enter the Delta via rivers and streams during high stream flow events (Pereira et al. 1995; USGS 2005; Leatherbarrow et al. 2006). Ecological effects of pesticide contamination (e.g., fish toxicity) reflect the cumulative influence of pesticides currently in use, those used historically, and the constantly changing new pesticides introduced for agricultural practices (CALFED Bay-Delta Program 2008a).

Pesticides are regulated at the federal level by USEPA, which administers pesticide regulations included in the Safe Drinking Water Act (SDWA) that sets MCLs for common pesticides (U.S. Environmental Protection Agency 2008d). Pesticides were identified in the CALFED Bay-Delta Program Water Quality Program Plan as constituents to monitor, although pesticides were generally found to be below levels of concern to drinking water (CALFED Bay-Delta Program 2000), Section 303(d) requires states to identify impaired water bodies and develop TMDLs for pesticides if they are limited to adverse effects on aquatic life or other beneficial uses of water bodies, thereby impairing the use.

The Department of Pesticide Regulation, an agency within the California Environmental Protection Agency (Cal/EPA), is charged with administering California's statewide pesticide regulatory program, the largest of its kind in the nation. It administers the CCR Title 6 (Food and Agriculture), which restricts the use of pesticides near water bodies and establishes Pesticide Management Zones and reporting requirements for pesticide use. The Department of Pesticide Regulation also conducts pesticide-monitoring activities. It and other agencies responsible for water quality, such as State Water Board, promote use of Best Management Practices and other preventive measures to reduce pesticide contamination of water bodies. For example, rice growers are required to hold water on their fields following application of rice pesticides to allow for degradation of pesticides to occur, reducing concentrations contained in rice field runoff that enters waterways adjacent to treated fields (Newhart 2002).

Importance in the Project Area

Organophosphates have been shown to be present at elevated concentrations in tributaries and the Delta, and pyrethroids at toxic concentrations have been detected in water bodies draining agricultural areas in the Central Valley, as well as urban creeks in the Delta region (Werner et al. 2008; Weston and Lydy 2010). The Section 303(d) list of impaired water bodies identifies nine locations in the Delta where water quality is impaired by legacy pesticides (State Water Resources Control Board 2011).

The critical pathways for pesticides entering the Delta include agricultural and urban stormwater runoff, irrigation return water, drift from aerial or ground-based spraying, and periodic release of agricultural return flows from rice production (Werner and Oram 2008). Agricultural inputs are dominant, but urban inputs are also substantial in areas of high population density (CALFED Bay-Delta Program 2008a), and appear to be a primary source of pyrethroid insecticides entering urban creeks. For example, Weston and Lydy (2010) demonstrated that urban runoff produced pyrethroid concentrations exceeding acutely toxic thresholds. The authors also found that the pyrethroids passed through secondary treatment systems at wastewater treatment facilities, suggesting possible sewer disposal of pyrethroids (e.g., household pesticides).

The fate and effects of pesticide mixtures in the Delta and the implications of pesticide mixtures for populations of native species are not well understood (CALFED Bay-Delta Program 2008a; Werner and Oram 2008). Monitoring data for pyrethroids in water and sediment are scarce or do not exist, confounding attempts to estimate loads of pyrethroids transported to the Delta from the Central Valley (Werner and Oram 2008; TDC Environmental 2010). Implementation of TMDLs has reduced concentrations of some pesticides in the Delta (e.g., chlorpyrifos and diazinon); incidences of toxicity attributable to organophosphate pesticides have substantially declined compared to observations in the early 1990s (CALFED Bay-Delta Program 2008b).

There was a large monitoring effort from 1988 to 1993 to assess pesticides in the Delta for DDT compounds (DDT, DDE, and DDD), the "Group A Pesticides," as well as chlorpyrifos, diazinon, atrazine, and thiobencarb (BDAT 2009). The stations from this monitoring that coincide with the present stations examined include the San Joaquin River at Buckley Cove, Sacramento River at Hood (actually collected at Greene's Landing), Sacramento River above Point Sacramento, San Joaquin River at Antioch Ship Channel, Old River at Rancho Del Rio, Suisun Bay at Bulls Head Point near Martinez, and Franks Tract. Analysis of the monitoring results indicated that most pesticides were near or below laboratory detection limits.

Existing Conditions in the Project Area

The following discussion of diazinon and chlorpyriphos represents an example of pesticide dynamics in the Delta (Central Valley Regional Water Quality Control Board 2006). While these insecticides have uses in urban areas, general public use (e.g., over-the-counter purchase) has been greatly limited because of regulation. In agricultural applications, they are applied during the dormant season (December through February) and the irrigation season (March through November). Dormant orchards (nuts and fruits) are sprayed to limit pest damage. Application totals for diazinon (1999–2003 average) were 52% dormant season and 48% irrigation season (47,652 pounds total); application totals for chlorpyrifos (1999–2003 average) were 3% dormant season and 97% irrigation season (114,101 pounds total).

Monitoring for diazinon suggests that higher concentrations occur in Delta back sloughs and small upland drainages, with lower concentrations occurring in Delta island drains, main rivers, and tributaries (Table 8-32). Monitoring for chlorpyrifos suggests that higher concentrations occur in Delta back sloughs, Delta island drains, and small upland drainages, with lower concentrations occurring in main rivers and tributaries (Table 8-33).

Table 8-32. Diazinon Concentrations, by Water Body Category

Water Body Type	No. of Samples	Median Concentration (ng/L)	90th Percentile Concentration (ng/L)	Maximum Concentration (ng/L)	Samples >160 ng/L[a]
Delta Back Sloughs	352	13	300	1,400	56 (16%)
Delta Island Drains	57	0	17	82	0 (0%)
Delta Rivers and Main Delta Waterways	774	0	97	797	31 (4%)
Major Delta Tributaries	2,056	0	80	1,700	106 (5%)
Small Upland Drainages	146	16	150	2,790	13 (9%)

Source: Central Valley Regional Water Quality Control Board 2006.
Note: ng/L = nanograms per liter
[a] Proposed acute toxicity water quality objective for diazinon to protect invertebrates

Table 8-33. Chlorpyrifos Concentrations, by Water Body Category

Water Body Type	No. of Samples	Median Concentration (ng/L)	90th Percentile Concentration (ng/L)	Maximum Concentration (ng/L)	Samples >25 ng/L[a]
Delta Back Sloughs	373	0	68	677	62 (17%)
Delta Island Drains	57	5	46	360	11 (19%)
Delta Rivers and Main Delta Waterways	722	0	0	76	7 (1%)
Major Delta Tributaries	1,887	0	7	700	32 (2%)
Small Upland Drainages	148	0	87	180	35 (24%)

Source: Central Valley Regional Water Quality Control Board 2006.
Note: ng/L = nanograms per liter
[a] Proposed acute toxicity water quality objective for chlorpyrifos to protect invertebrates

More recent monitoring efforts to assess these and other examined pesticides are limited to four of the selected locations for this section, including the Banks pumping plant, the Barker Slough Pumping Plant, the Sacramento River above Point Sacramento, and the San Joaquin River at Antioch Ship Channel. The latter two stations were sampled for pesticides on an annual basis by SFEI as part of its monitoring program (denoted as stations BG20 and BG30, respectively). The SFEI laboratory reporting limits are on the order of picograms per liter (pg/L), which are about 10,000 times more sensitive than the laboratory reporting limits for the Banks and Barker Slough Pumping Plants. This difference is evident in that there were very few analyte detections for these two stations.

Analytes examined in the present effort for the Banks and Barker Slough Pumping Plants include the "Group A Pesticides" (aldrin, dieldrin, chlordane, endrin, heptachlor, heptachlor epoxide, lindane, endosulfan, and toxaphene), DDT products (p,p'-DDD, p,p'-DDE, and p,p'-DDT), atrazine, chlorpyrifos, diazinon, glyphosate, malathion, molinate, methyl parathion, permethrin, simazine, and thiobencarb. The monitoring program sampled for these analytes approximately 16 times during the water years 2001 to 2006 for each location. Detections were limited to those presented in Table 8-34.

Table 8-34. Pesticide Concentrations at the Harvey O. Banks and Barker Slough Pumping Plants, Water Years 2001–2006

Pesticide	Harvey O. Banks	Barker Slough
Chlorpyrifos	0.03 μg/L (3/16/05)	—
Diazinon	0.01 μg/L (3/21/01)	0.01 μg/L (3/21/01)
Molinate	0.04 μg/L (6/16/04)	0.04 μg/L (6/15/04)
Simazine	0.12 μg/L (3/21/01)	0.02 μg/L (3/21/01)
	0.02 μg/L (3/20/02)	0.24 μg/L (3/16/05)
	0.11 μg/L (3/16/05)	0.02 μg/L (6/15/05)
	0.05 μg/L (3/15/06)	0.46 μg/L (3/15/06)

Source: BDAT 2009.
Notes: Data represent water quality samples having values at or greater than the reporting limit.
μg/L = micrograms per liter

These detections generally occurred during the wet season during wet years. The exception is for molinate, which was detected during the early summer of a dry year (2004).

As mentioned previously, laboratory detection limits for the SFEI laboratory are on the order of pg/L. These very low detection limits have enabled the detection of many pesticides examined in the current study, as indicated in Table 8-35.

The samples were taken between late July and late August, which does not allow examination of wet versus dry season effects. The results suggest that many of the "legacy" pesticides are still present in the Sacramento River and San Joaquin River outflows during summer conditions, albeit at low concentrations. Chlorpyrifos, diazinon, and DDT median concentrations were higher than the other pesticides; median concentrations for nearly all pesticides were higher in the Sacramento River compared to the San Joaquin River.

Monitoring efforts at the north of Delta stations since 2001 have resulted in no pesticide detects, while monitoring at the south of Delta stations resulted in various detections. The California Aqueduct at Check 13 had detects for chlorpyrifos (3/15/05, 0.02 µg/L), diazinon (3/20/01, 0.01 µg/L), and metolachlor (6/14/05, 0.1 µg/L), as well as numerous detects for diuron (8 detects between 3/15/00 and 9/15/09, ranging from 0.27 to 3.2 µg/L) and simazine (13 detects between 3/15/00 and 9/15/09, ranging from 0.02 to 0.14 µg/L). The California Aqueduct at Check 29 had detects for chlorpyrifos (9/20/05, 0.01 µg/L) and dacthal (9/19/07, 0.12 µg/L), as well as numerous detects for diazinon (4 detects between 3/20/01 and 6/22/06, ranging from 0.01 to 0.03 µg/L), diuron (7 detects between 3/14/00 and 9/15/09, ranging from 0.29 to 1.2 µg/L) and metolachlor (detects on 6/15/04 and 6/21/05, 0.01 and 0.01 µg/L).

Regulatory criteria with respect to pesticides are as follows. Pesticides on the Section 303(d) list include chlordane (San Francisco Bay, source: nonpoint), chlorpyrifos (Central Valley, sources: agriculture, urban runoff/storm sewers), DDT (San Francisco Bay, source: nonpoint; Central Valley, source: agriculture), diazinon (Central Valley, sources: agriculture, urban runoff/storm sewers), dieldrin (San Francisco Bay, source: nonpoint), and Group A pesticides (Central Valley, source: agriculture). The Central Valley Regional Water Quality Control Board and San Francisco Bay Regional Water Quality Control Board Basin Plans contain narrative objectives for pesticides and toxicity.

There are several pesticides with water quality criteria listed under the CTR, the Central Valley Regional Water Quality Control Board Basin Plan, the San Francisco Bay Regional Water Quality Control Board Basin Plan, and the California drinking water MCLs (Table 8-1). There were no exceedances for the Central Valley Regional Water Quality Control Board Basin Plan chlorpyrifos or diazinon objectives. No criteria are listed for the San Francisco Bay Regional Water Quality Control Board Basin Plan for the pesticides examined. No California drinking water MCLs were exceeded at the stations examined.

A target list of pesticides has been developed by the Central Valley Regional Water Quality Control Board (2009e) for the purpose of risk assessment in the project area. The list was based on work by Urban Pollution Prevention Projects for the San Francisco Estuary Project (TDC Environmental 2008). Eight of the 38 pesticides considered highly toxic to aquatic organisms are pyrethroids, and the process has begun to establish water quality criteria for bifenthrin, lamda-cyhalothrin, and cyfluthrin (Central Valley Regional Water Quality Control Board 2010b).

Table 8-35. Pesticide Concentrations at the Mouths of the Sacramento and San Joaquin Rivers, Water Years 2001–2006

		Sacramento River above Point Sacramento (μg/L)					San Joaquin River at Antioch Ship Channel (μg/L)				
Pesticide	Fraction	Samples	Min.	Max.	Mean	Median	Samples	Min.	Max.	Mean	Median
Aldrin	Dissolved	4	1	3	2	2	2	<1	2	1	1
Aldrin	Total	1	4	4	4	4	1	3	3	3	3
Chlorpyrifos	Dissolved	4	300	1,070	719	753	4	76	789	486	541
Chlorpyrifos	Total	4	332	1,070	727	753	4	90	789	490	541
Diazinon	Dissolved	3	511	765	599	520	4	229	1079	515	375
Diazinon	Total	3	511	765	599	520	4	229	1079	605	557
Dieldrin	Dissolved	7	56	110	85	82	5	49	81	68	73
Dieldrin	Total	7	60	117	89	84	6	52	87	74	77
Endosulfan I	Dissolved	5	11	57	32	31	2	13	13	13	13
Endosulfan I	Total	2	31	43	37	37	3	13	35	20	13
Endosulfan II	Dissolved	1	34	34	34	34	1	3	3	3	3
Endosulfan II	Total	0					1	3	3	3	3
Endrin	Dissolved	4	2	2	2	2	3	2	2	2	2
Endrin	Total	2	2	2	2	2	2	2	2	2	2
Heptachlor	Dissolved	4	<1	2	1	1	1	1	1	1	1
Heptachlor	Total	2	2	3	2	2	1	1	1	1	1
Heptachlor Epoxide	Dissolved	7	2	24	7	4	5	4	15	6	4
Heptachlor Epoxide	Total	6	2	24	7	4	4	3	15	6	4
Sum of Chlordanes	Dissolved	6	25	106	48	40	5	20	55	37	30
Sum of Chlordanes	Total	5	20	143	66	51	4	27	68	46	45
Sum of DDTs	Dissolved	7	153	227	188	194	5	93	144	124	131
Sum of DDTs	Total	7	266	546	368	366	6	175	257	214	210

Source: SFEI Website 2010.

Notes: All units in picograms per liter (pg/L). Sample size represents water quality samples having values at or greater than the reporting limit. Values for "dissolved" may exceed "total" because of rejected laboratory samples.

DDT = dichlorodiphenyltrichloroethane; Max. = maximum; Min. = minimum

8.1.3.14 Boron

Background

Boron is a naturally occurring compound found in sediments and sedimentary rocks in the form of borates (e.g., boron oxide, boron acid, borax). Natural weathering of rocks is thought to be the primary source of boron compounds in water and soil (ATSDR 2007). Human uses of boron compounds include production of glass, ceramics, soaps, fire retardants, pesticides, cosmetics, photographic materials, and high-energy fuels (U.S. Environmental Protection Agency 2008e). Agricultural supply beneficial uses are potentially the most sensitive receptor to boron concentrations as a result of the potential for toxic effects on crops and reduced yields (Table 8-1).

Even though it is found naturally in many fruits and vegetables, boron does not accumulate in human tissues (Waggot 1969; Butterwick et al. 1989). While boron may possibly serve as a trace mineral nutrient for humans, it has potential detrimental health effects such as nausea, vomiting, swallowing difficulties, diarrhea, and rashes due to acute overdoses (U.S. Environmental Protection Agency 2008f). Related effects have also occurred in animals. Aquatic plants and animals accumulate boron, but residues do not increase through the food chain (Moore 1991).

The richest deposits in the United States are located in California (sediments and brines). Other natural sources include releases to air from oceans, volcanoes, and geothermal steam (Graedel 1978). Total natural global releases of boron from weathering, volcanoes, and geothermal steam are approximately 360,000 metric tons per year (Moore 1991), while releases from seawater range from 800,000 to 4,000,000 metric tons per year (U.S. Environmental Protection Agency 2008f).

Anthropogenic releases of boron compounds occur through such pathways as air emissions (power plants, chemical plants, manufacturing facilities), soils (fertilizers, herbicide, and industrial wastes), and water (industrial wastewaters, municipal sewage) (ATSDR 2007). Approximately 180,000 to 650,000 metric tons of boron are released annually into the atmosphere from the industries that use boron and boron-containing products (U.S. Environmental Protection Agency 2008f).

USEPA recently evaluated boron and its potential for contamination of drinking water supplies (73 Federal Register 44,251–44,261), and made a determination not to regulate boron with a National Primary Drinking Water Regulation. Because boron is not likely to occur at concentrations of concern when considering both surface and groundwater systems, USEPA believes that a National Primary Drinking Water Regulation does not present a meaningful opportunity for healthrisk reduction.

Importance in the Project Area

Excessive concentrations of boron in irrigation water can lower crop yields, in addition to human consumption concerns from Delta drinking water diversions. In a study of groundwater from the Sacramento Valley aquifer, boron was detected in all 31 samples, in concentrations ranging from 12 μg/L to 1,100 μg/L (Dawson 2001). The median concentration was 42 μg/L. Two of the 31 samples had concentrations in excess of the then-current Health Advisory Level of 600 μg/L.

Assessment of how human atmospheric emission sources of boron in the Delta directly affect the Delta would be difficult, given the complexity of area meteorology. Such sources would need to be identified and undergo air transport modeling to determine deposition rates onto land and water in the Plan Area. Human activities related to boron land and water emissions may be more easily quantified. Land applications of boron in the Delta may include fertilizer, herbicide, and industrial waste, while water sources may include industrial wastewaters, municipal sewage, and agricultural return drains.

The Lower San Joaquin River is listed on the Section 303(d) list as impaired for salinity and boron. The impairment extends from downstream of the Mendota Pool to the Airport Way Bridge near Vernalis. The Section 303(d) listing requires development of a TMDL for salinity and boron in the Lower San Joaquin River (California Environmental Protection Agency 2008). The salinity and boron water quality objectives in the lower San Joaquin River at Vernalis have not been exceeded since 1995. The standard is a 30-day running average.

Approximately 85% of the boron load originates from the western side of the Lower San Joaquin River, represented by the Grasslands and Northwest Side Subareas. Agricultural drainage, discharge from managed wetlands, and groundwater accretions are the principle sources of boron loading to the river. Additionally, large-scale, out-of-basin water transfers have reduced the assimilative capacity of the river, thereby exacerbating the water quality issues associated with boron.

The source analysis contained in the Central Valley Regional Water Quality Control Board's TMDL describes the magnitude and location of the sources of boron loading to the Lower San Joaquin River. The watershed is divided into seven component subareas to elucidate differences in boron loading between different geographic areas (Figure 8-52).

Contributions of boron to the Delta also originate from other sources, including the Sacramento River, the East Delta tributaries, Delta agricultural return drains, and the San Francisco Bay. The next section describes how all of these sources, in addition to the San Joaquin River, contribute to boron concentrations in the Delta.

Existing Conditions in the Project Area

Most examined locations in the Delta have had low concentrations of boron in recent years (water years 2001–2006), with mean values typically ranging from 0.1 to 0.3 mg/L (Figure 8-53). The Sacramento River at Mallard Island location had a mean value of 0.5 mg/L. Maximum boron values were typically in the 0.1 to 0.5 mg/L range, with higher values at the San Joaquin River near Vernalis (0.8 mg/L) and the Sacramento River at Mallard Island (1.5 mg/L).

Minimal data were available for the north of Delta area, while the mean value for the south of Delta stations was 0.2 mg/L (Table 8-36).

Time series data indicate that boron concentrations at the examined stations generally fluctuate on an annual basis (Figure 8-54 and Figure 8-55). Higher values have tended to occur during the months of November through March.

Table 8-36. Boron Concentrations at Selected North and South of Delta Stations, Water Years 2001–2006[a]

	Boron (dissolved, mg/L)				
Location	Samples	Minimum	Maximum	Mean	Median
Sacramento River at Keswick	1	—	—	0.1	—
Sacramento River at Verona	n/a	—	—	—	—
Feather River at Oroville	n/a	—	—	—	—
American River at WTP	n/a	—	—	—	—
California Aqueduct at Check 13	64	0.1	0.4	0.2	0.2
California Aqueduct at Check 29	74	0.1	0.3	0.2	0.2

Source: DWR 2009b.
Notes:
mg/L = milligrams per liter
n/a = not available
WTP = water treatment plant
[a] Sample size represents water quality samples having values at or greater than the reporting limit.

Regulatory criteria with respect to boron are as follows. There are no numerical water quality objectives for the Delta in the CTR and the Central Valley Regional Water Quality Control Board Basin Plan, and there are no California drinking water MCLs associated with boron. However, the Central Valley Regional Water Quality Control Board Basin Plan limits monthly average boron concentrations in the San Joaquin River inflow at Vernalis to 2 mg/L from September 15 to March 15, and to 0.8 mg/L at other times. The San Francisco Bay Regional Water Quality Control Board Basin Plan water quality objective of 2 mg/L boron for agricultural supply –irrigation and 5 mg/L boron for agricultural supply – livestock watering, were not exceeded at the locations examined. With respect to Basin Plan narrative objectives, boron might be considered under the general "chemical" objective for its potential to adversely affect agricultural water supply.

8.1.3.15 Dioxins, Furans, and Polychlorinated Biphenyls

Background

Dioxins are a group of chemical compounds with similar chemical structures and biotic effects (USFDA 2009). There are several hundred of these compounds, which can be grouped into three families: chlorinated dibenzo-p-dioxins, chlorinated dibenzofurans, and certain polychlorinated biphenyls (PCBs). One of the most toxic (and most studied) dioxin is 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD). Chlorinated dibenzo-p-dioxins and chlorinated dibenzofurans are created unintentionally, usually through combustion processes. PCBs are manufactured products, but are no longer produced in the United States. Dioxins break down very slowly in the environment, indicating that past and present emissions will continue to interact with soils, water, and biota (e.g., Wenning et al. 1999; Gullett et al. 2003; Brown et al. 2006).

The most common health effect in people exposed to large amounts of dioxins is chloracne, possibly followed by skin rashes, skin discoloration, excessive body hair, and possibly mild liver damage (USFDA 2009). A substantial concern is the cancer risk associated with dioxins. High exposures over long periods (animal studies, human workplace studies) have suggested an increased cancer risk as well as possible reproductive and developmental effects. Toxicity levels are very broad between the various dioxin compounds, up to several orders of magnitude. The health effects associated with dioxins depend on a variety of factors including the level of exposure, when someone was exposed, and for how long and how often.

PCBs can cause developmental abnormalities, growth suppression, disruption of the endocrine system, impairment of immune function, and cancer (State Water Resources Control Board2007b). PCBs can bioaccumulate and reach higher concentrations in higher levels of aquatic food chains; predatory fish, birds, and mammals (including humans that consume fish) at the top of the food web are particularly vulnerable to the effects of PCB contamination. Consequently, the beneficial uses most directly affected by dioxin/furan compounds and PCBs include aquatic organisms (cold freshwater habitat, warm freshwater habitat, and estuarine habitat), Rare, Threatened and/or Endangered species if the community population level were to be reduced by exposure through the aquatic environment, harvesting activities that depend on aquatic life (shellfish harvesting/ commercial and sport fishing), and drinking water supplies (municipal and domestic supply) (Table 8-1).

Dioxins may enter the environment through air, water, and land pathways. Because the majority of dioxin releases are to the atmosphere, some dioxins can be transported very long distances and can be found in most places in the world (National Research Council 2006; USFDA 2009). In water, dioxins tend to settle into sediments where they can move up the food chain. Dioxins can also be deposited on plants and enter the food chain. Animals tend to accumulate dioxins in fatty tissues.

USEPA (2006d) estimated that the primary pathway of dioxin releases to the environment is atmospheric (92.4%), with 5.7% to the land and 1.8% to water. It is important to note that this estimate did not include natural sources of dioxins, which exceed those produced by human activities (Centers for Disease Control 2005). Dioxins are ubiquitous, and all living organisms have had some form of low-level exposure. Natural brush and forest fires produce dioxins, so it is reasonable to assume that organisms have been exposed to dioxins for centuries. Placed into context, one can see that 54% of dioxin sources were from natural forest fires in 2004, with the remainder coming from anthropogenic sources (Figure 8-56).

PCBs were commonly used in the United States for the production of transformers and capacitors in electrical equipment (Brinkmann and de Kok 1980). Other uses included hydraulic fluids, lubricants, inks, and as a plasticizer (State Water Resources Control Board 2007). While production of transformers and capacitors containing PCBs ended in the United States in 1979, the persistent nature of PCBs in the environment is still a source of concern (Davis et al. 2007).

Importance in the Project Area

Assessment of how human atmospheric emission sources of dioxins, furans, and PCBs in the project area directly affect the Delta would be difficult, given the complexity of area meteorology. Based on the USEPA (2006c) analysis, the major sources would likely be backyard barrel burning of refuse and medical waste/pathological incineration. Such sources would need to be identified and undergo air transport modeling to determine deposition rates onto land and water in the Plan Area.

Human activities related to land and water emissions may be more easily quantified and, based on the USEPA (2006c) analysis, would likely be dominated by application of municipal wastewater treatment sludge (land), ethylene dichloride/vinyl dichloride production (land, water), chlor alkali facilities (water), and bleached, chemical wood pulp and paper mills (water).

Existing Conditions in the Project Area

There are two portions in the project area that are on the Section 303(d) listing for impairment with respect to dioxins, furans, and PCBs. The Stockton Ship Channel is listed for dioxins/furans for the overall channel, while 3.3 miles of the Channel are listed for PCBs. The North Delta has a PCB impairment listing for 15.5 miles of drainage canal near Sacramento.

Hayward et al. (1996) found that sediment concentrations of dioxins and furans near a USEPA Superfund site in the Stockton area (specifically, a wood treatment facility) were highly localized and likely attributable to pentachlorophenol use at the facility.

Contributions of dioxins to the Delta originate from several sources, including the Sacramento River, the San Joaquin River, the East Delta tributaries, Delta agricultural return drains, and the San Francisco Bay. The section below quantifies how these sources contribute to concentrations in the Delta.

Minimal dioxin and furan data have been collected as part of water quality monitoring programs in the project area. For example, pentachlorophenol and carbofuran have been analyzed at the Banks pumping plant three times a year since 1995, but with no detections.

There was a large monitoring effort from 1988 to 1993 to assess PCBs in the Delta. Analytes examined included PCB-1016, PCB-1221, PCB-1232, PCB-1242, PCB-1248, PCB-1254, and PCB-1260 (BDAT 2009). The stations from this monitoring that coincide with the stations examined in this section include the San Joaquin River at Buckley Cove, Sacramento River at Hood (actually collected at Greene's Landing), Sacramento River above Point Sacramento, San Joaquin River at Antioch Ship Channel, Old River at Rancho Del Rio, Suisun Bay at Bulls Head Point near Martinez, and Franks Tract. Analysis of the monitoring results indicated that no detections were found.

Recent monitoring efforts to assess PCBs in the Plan Area are limited to four of the selected locations, including the Banks pumping plant, the Barker Slough Pumping Plant, the Sacramento River above Point Sacramento, and the San Joaquin River at Antioch Ship Channel. The latter two stations were sampled for PCBs on an annual basis by SFEI as part of its monitoring program (denoted as stations BG20 and BG30, respectively). The SFEI laboratory reporting limits are on the order of 0.01 pg/L, which are about 10,000,000 times more sensitive than the laboratory reporting limits for the Banks and Barker Slough pumping plants.

Analytes examined in the present effort for the Banks and Barker Slough Pumping Plants include PCB-1016, PCB-1221, PCB-1232, PCB-1242, PCB-1248, PCB-1254, and PCB-1260. The monitoring program sampled for each of these analytes approximately 16 times during the water years 2001 to 2006 for each location. No detections were found.

Forty different PCB compounds ranging from PCB 008 to PCB 203 were examined by the SFEI laboratory for the Sacramento River above Point Sacramento and the San Joaquin River at Antioch Ship Channel locations. As mentioned previously, laboratory detection limits for the SFEI laboratory are on the order of pg/L. These very low detection limits have enabled the detection of many PCBs examined in the current study, which are presented as the sum of all PCBs in Table 8-37.

Table 8-37. Sum of All Polychlorinated Biphenyls at the Mouths of the Sacramento and San Joaquin Rivers, Water Years 2001–2006

Sum of all PCBs	Samples	Minimum (pg/L)	Maximum (pg/L)	Mean (pg/L)	Median (pg/L)
Sacramento River above Point Sacramento					
Dissolved	7	35	70	52	50
Total	6	67	138	99	95
San Joaquin River at Antioch Ship Channel					
Dissolved	5	47	60	53	53
Total	5	70	254	120	98

Source: SFEI Website 2010.

Notes: All concentrations in picograms per liter (pg/L). Sample size represents water quality samples having values at or greater than the reporting limit.

PCB = polychlorinated biphenyl

The samples were taken between late July and late August, which does not allow examination of wet versus dry season effects. The results indicate that all selected PCBs are still present in the Sacramento and San Joaquin River outflows during summer conditions, albeit at low concentrations. Values for PCBs were comparable between the two locations.

Sampling at south of Delta locations at California Aqueduct Check 13 and Check 29 for the same constituents also resulted in no detections during the same time period. Sampling at the north of Delta locations (approximately 35 to 60 visits per site) resulted in multiple detects at the Sacramento River at Keswick, the Feather River at Oroville, and the Sacramento River at Verona; however, the sampling and analytical protocol for these data were not available and the validity of the data could not be confirmed.

Regulatory criteria with respect to dioxins, furans, and PCBs are as follows. Dioxin compounds are on the Section 303(d) list for the San Francisco Bay (source of contamination unknown) and the Central Valley (source: unknown point source near Stockton Deep Water Ship Channel). Furan compounds are on the Section 303(d) list for the San Francisco Bay (source: atmospheric deposition) and the Central Valley (source: contaminated sediments). PCBs and dioxin compounds are on the Section 303(d) list for the San Francisco Bay (sources: unknown nonpoint, unknown).

With regard to Basin Plan narrative objectives, any of the compounds above might be considered "toxic" at high concentrations. There are no numerical water quality objectives for the San Francisco Bay Regional Water Quality Control Board or Central Valley Regional Water Quality Control Board Basin Plans. The California drinking water standard MCL for 2,3,7,8-TCDD is 0.00000003 mg/L; the MCL for carbofuran in 0.018 mg/L. The CTR for 2,3,7,8-TCDD is 0.000000013 µg/L for Human Health: Water and Organisms, and 0.000000014 µg/L for Human Health: Organisms Only. Data are inadequate to assess whether the sites examined in this SFEI monitoring exceeded this standard.

The CTR criteria for PCBs (sum of 6 aroclors) is 0.014 µg/L (freshwater chronic), 0.03 µg/L (saltwater chronic), 0.00017 µg/L (Human Health: Water and Organisms), and 0.00017 µg/L (Human Health: Organisms Only). Data examined in this study indicate that these criteria have not been exceeded.

8.1.3.16 Polycyclic Aromatic Hydrocarbons

Background

PAHs are toxic compounds formed primarily as products of incomplete combustion (burning) of substances such as gasoline, coal, oil, wood, garbage, grilled meat, and tobacco (ATSDR 1995). Some PAHs are manufactured for specific uses such as asphalt, creosote, roofing tar, medicines, dyes, pesticides, and plastics. Mahler et al. (2005) suggest that parking lot sealcoat can be a major source of PAHs to urban water bodies. PAHs in the environment tend to be found together as complex mixtures rather than single compounds (Oros et al. 2007).

PAHs can lead to red blood cell damage, leading to anemia, suppressed immune system, developmental and reproductive effects, and possibly cancer over a lifetime of exposure (U.S. Environmental Protection Agency Website 2009h). Wildlife effects (e.g., mammals, birds, invertebrates, plants, amphibians, and fish) have also been observed (Eisler 1987). The typical means of exposure to PAHs occurs through inhalation. Other exposure pathways include skin contact of PAH-containing products and ingestion of foods and liquids containing PAH compounds. Consequently, the beneficial uses most directly affected by PAHs include aquatic organisms (cold freshwater habitat, warm freshwater habitat, and estuarine habitat); Rare, Threatened and/or Endangered species, if the community population level were to be reduced by exposure through the aquatic environment; harvesting activities that depend on aquatic life (shellfish harvesting and commercial and sport fishing); and drinking water supplies (municipal and domestic supply) (Table 8-1).

PAHs enter the environment mostly as releases to air from volcanoes, forest fires, residential wood burning, and exhaust from automobiles and trucks (ATSDR 1995). They can also enter surface water through discharges from industrial plants and wastewater treatment plants, and they can be released to soils at hazardous waste sites if they escape from storage containers.

PAHs are present in air as vapors or adhere to the surfaces of small solid particles. They can travel long distances before they return to earth via rainfall or particle settling. Some PAHs evaporate into the atmosphere from surface waters, but most stick to solid particles and settle to the bottoms of rivers or lakes. The solubility of PAHs in water is often very low. PAHs stay adsorbed to soil particles, although some tend to evaporate and/or contaminate groundwater.

PAHs can break down to longer-lasting products by reacting with sunlight and other chemicals in the air, generally over a period of days to weeks. Breakdown in soil and water generally takes weeks to months, and is caused primarily by the actions of microorganisms.

Benzo[a]pyrene is an example of an environmental PAH that can behave as described above (U.S. Environmental Protection Agency Website 2009h). Benzo[a]pyrene is expected to bioconcentrate in aquatic organisms that can not metabolize it. Reported bioconcentration factors include: Oysters, 3000; Rainbow Trout, 920; Bluegills, 2,657; zooplankton, 1,000 to 13,000. The presence of humic acid in solution has been shown to decrease bioconcentration. Those organisms that lack a metabolic detoxification enzyme system tend to accumulate these compounds. For example, bioconcentration factors have been found to be very low (<1) for Mudsuckers, Sculpins, and Sand Dabs.

There are two major sources of PAHs in drinking water: contamination of raw water (untreated) supplies from natural and human-made sources, and leachate from coal tar and asphalt linings in water storage tanks and distribution lines. PAHs in raw water will tend to adsorb to any particulate matter and be removed by filtration before reaching the drinking water supply. Background levels of PAHs in drinking water range from 4 to 24 ng/L (U.S. Environmental Protection Agency Website 2009h).

The MCL for benzo[a]pyrene is 0.0002 mg/L. Potential health effects from exposure above the MCL include reproductive difficulties and increased risk of cancer. The public health MCLG is a concentration of zero (U.S. Environmental Protection Agency Website 2009h).

Importance in the Project Area

Assessment of how human atmospheric emission sources of PAHs in the project area directly affect the area would be difficult, given the complexity of area meteorology. Such sources would need to be identified and undergo air transport modeling to determine deposition rates onto land and water in the Plan Area. Human activities related to PAH land and water emissions may be more easily quantified. Land applications of PAHs in the project area may include unintended releases from hazardous waste containers, while water sources may include industrial wastewaters, municipal sewage, and stormwater runoff.

The Regional Monitoring Program for Water Quality in the San Francisco Estuary has monitored PAHs and other pollutants in San Francisco Bay water, sediments, and bivalves since 1993 at several locations, including the mouths of the Sacramento and San Joaquin Rivers near Antioch.

In an analysis of 1993–2001 data, Ross and Oros (2004) found the distribution of median total PAH concentration by estuary segment was as follows.

- Extreme South Bay (120 ng/L).
- South Bay (49 ng/L).
- North Estuary (29 ng/L).
- Central Bay (12 ng/L).
- Delta (7 ng/L).

These results suggest that the Delta is not a major contributor of PAHs to San Francisco Bay. Using PAH isomer pair ratio analysis, Ross and Oros (2004) showed that PAHs in estuary waters were derived primarily from combustion of fossil fuels/petroleum (possible PAH source contributors include coal, gasoline, kerosene, diesel, No. 2 fuel oil, and crude oil) and biomass (possible contributors include wood and grasses), with lesser amounts of PAH contributed from direct petroleum input.

A modeling exercise of PAHs in San Francisco Bay ranked PAH loading pathways as stormwater runoff (51%), tributary inflow (28%), wastewater treatment plant effluent (10%), atmospheric deposition (8%), and dredged material disposal (2%) (Greenfield and Davis 2005; Oros et al. 2007). A study of PAH inputs and sources (surface water, stream, precipitation) along an urban tributary to the Sacramento River took place in 2004 and 2005 (Kim and Young 2009).

Surface water concentrations varied from 192 to 3,784 ng/L for total PAHs and 18 to 48 ng/L for dissolved PAHs. Precipitation concentrations varied from 77 to 236 ng/L for total PAHs and 15 to 66 ng/L for dissolved PAHs. The authors suggest that indirect deposition (i.e., washoff of atmospheric particles previously deposited to land) of PAHs into surface water are a more likely substantial input pathway for total PAHs than direct dry or wet deposition during the wet season. They also assert that particulate matter carried by stormwater runoff was the major source of PAHs in surface water in the early rainy season.

Existing Conditions in the Project Area

Recent monitoring efforts to assess PAHs are very limited with respect to our selected locations. For example, naphthalene had been sampled at three pumping plants (Banks, Barker Slough, CCWD #1) and the San Joaquin River at Vernalis since the late 1990s with no laboratory detections.

The Sacramento River above Point Sacramento and the San Joaquin River at Antioch Ship Channel were sampled for 24 different PAH compounds on an annual basis by SFEI as part of its monitoring program (denoted as stations BG20 and BG30, respectively). The SFEI laboratory reporting limits are on the order of pg/L, which are orders of magnitude more sensitive than the laboratory reporting limits for the Banks and Barker Slough Pumping Plants. These very low detection limits have enabled the detection of many PAHs examined in the current study, which are presented as the sum of all PAHs in Table 8-38.

Table 8-38. Sum of All Polycyclic Aromatic Hydrocarbons at the Mouths of the Sacramento and San Joaquin Rivers, Water Years 2001–2006

Sum of all PAHs	Samples	Minimum (pg/L)	Maximum (pg/L)	Mean (pg/L)	Median (pg/L)
Sacramento River above Point Sacramento					
Dissolved	7	2,240	17,444	8,962	9,359
Total	6	9,090	29,205	16,510	15,415
San Joaquin River at Antioch Ship Channel					
Dissolved	5	1,380	16,637	9,881	9,331
Total	6	6,472	21,972	14,117	15,017

Source: SFEI Website 2010.

Notes: All concentrations in picograms per liter (pg/L). Sample size represents water quality samples having values at or greater than the reporting limit.

PAH = polycyclic aromatic hydrocarbon

The samples were taken between late July and late August, which does not allow examination of wet versus dry season effects. The results indicate that PAHs are present in the Sacramento and San Joaquin River outflows during summer conditions, albeit at low concentrations. Values for PAHs were comparable between the two locations. No detections were reported in the data examined for the north and south of Delta sampling locations.

Regulatory criteria with respect to PAHs are as follows. There are no listings for PAHs on the Section 303(d) list in the Delta. With regard to Basin Plan narrative objectives, PAHs might be considered "toxic" at high concentrations. There are no numerical water quality objectives for the Central Valley Regional Water Quality Control Board or San Francisco Bay Regional Water Quality Control Board Basin Plans. The CTR criteria for benzo[a]pyrene is 0.0044 μg/L (Human Health: Water and Organisms) and 0.049 μg/L (Human Health: Organisms Only). The California drinking water standard MCL for benzo[a]pyrene is 0.0002 mg/L. Data are inadequate to assess whether the sites examined in this study exceeded the CTR or drinking water standard MCL.

8.1.3.17 Emerging Pollutants: Endocrine-Disrupting Compounds and Pharmaceutical and Personal Care Products

Background

Emerging water quality contaminants represent a broad range of chemicals that have not traditionally been part of monitoring programs because they were not deemed important until recently or the ability to quantify them had not been possible until recent laboratory advances allowed their detection. As such, data for these parameters in the project area are relatively sparse. The beneficial uses most directly affected by emerging pollutant concentrations include aquatic organisms (cold freshwater habitat, warm freshwater habitat, and estuarine habitat) and drinking water supplies (municipal and domestic supply) (Table 8-1). The focus of the following section is on two broad classes of emerging contaminants: EDCs and PPCPs.

Endocrine-Disrupting Chemicals

EDCs interfere with hormone (i.e., endocrine) systems in animals. Hormones are released by body organs (e.g., thyroid, ovaries, testes) and act as chemical messengers to other organs and tissues. Hormones bind with receptor sites in a way similar to how a key fits into a lock. Upon binding, the receptor carries out the hormone's instructions by either altering the cell's existing proteins or turning on genes that will build a new protein (U.S. Environmental Protection Agency Website 2009i). Both of these actions create reactions throughout the body. The hormone system operates from conception through old age, affecting development, reproduction, metabolism, and other crucial body functions.

The problem with EDCs is that they can bind to hormone receptor sites in the body. The effect of this action varies but usually involves altering the function of the hormone system (U.S. Environmental Protection Agency Website 2009i). For example, an EDC that mimics a natural hormone can result in over- or underproduction of a chemical or response (e.g., too much growth hormone) or generation of a response at an inappropriate time (e.g., producing insulin when not needed). Other EDCs can block natural hormones from binding. Overall, the action of EDCs is typically undesirable because EDCs can disrupt normal body function.

EDCs have also been studied with respect to their potential impacts on aquatic organisms (e.g., Snyder 2003, 2008). For example, studies of the impact of estrogen exposure to fish downstream of wastewater treatment plants have detected elevated levels of vitellogenin, a female-specific egg yolk protein, in male fish. In a 7-year study, investigators found that concentrations of estrogens/estrogen mimics observed in freshwaters could affect the sustainability of wild fish populations by altering the male population (Kidd et al. 2007).

Examples of EDCs include natural plant and animal compounds, metals (e.g., arsenic, cadmium, lead, and mercury), dioxins, PAHs, pesticides, PPCPs, and PCBs (Snyder 2008). Sources of anthropogenic EDCs include wastewater treatment plants, private septic systems, urban stormwater runoff, industrial effluents, landfill leachates, discharges from fish hatcheries and dairy facilities, runoff from agricultural fields and livestock enclosures, and land amended with biosolids or manure.

Wastewater treatment plants are just beginning to examine their ability to treat for EDCs, with an encouraging degree of success (e.g., Snyder 2008; Benotti et al. 2009; CCWD 2009). Related research suggests that estrogen compounds can be biodegraded in the stream sediments below plant outfalls (Bradley et al. 2009).

Pharmaceuticals and Personal Care Products

PPCPs generally represent products used by humans for personal health (e.g., prescription and over-the-counter drugs) or cosmetic (e.g., fragrances, lotions) reasons, as well as products used to enhance livestock growth or health (e.g., hormones, antibiotics).

PPCPs in the environment have not yet been shown to adversely affect human health, but some studies suggest that they contribute to ecological harm (U.S. Environmental Protection Agency Website 2009j). PPCPs have been found in most places sampled, but typically at very low concentrations. Research to study the long-term exposure to very low PPCP concentrations is in its infancy. Concern exists because so much is unknown about the effects of PPCPs and because the number of PPCPs is growing.

According to the USEPA (2009j), people contribute PPCPs to the environment when medication residues pass out of the body and into sewer lines, when externally-applied drugs and personal care products they use wash down the shower drain, and when unused or expired medications are placed in the trash. Wastewater treatment plant operators are just beginning to examine their ability to treat for PPCPs, with an encouraging degree of success (e.g., Snyder 2008; Benotti et al. 2009; CCWD 2009).

Given the hundreds of EDCs and PPCPs that currently exist, determining which compounds to monitor presents a challenge (e.g., Hoenicke et al. 2007; de Voogt et al. 2009; Southern California Coastal Water Research Project 2009). National reconnaissance studies have keyed in on several dozens of chemicals that are known to have, or may have the potential to, affect humans and wildlife.

The first nationwide study took place in 1999 and 2000, and examined 95 chemicals in 139 streams across 30 states (Kolpin et al. 2002). According to the study, the most frequently detected compounds were coprostanol (fecal steroid); cholesterol (plant and animal steroid); N,N-diethyltoluamide (insect repellant); caffeine (stimulant); triclosan (antimicrobial disinfectant); tri(2-chloroethyl)phosphate(fire retardant); and 4-nonylphenol (nonionic detergent metabolite). In a follow-up study, the most frequently detected chemicals targeted in surface water were cholesterol, metolachlor (herbicide), cotinine (nicotine metabolite), and β-sitosterol (natural plant sterol).

Importance in the Project Area

Studies of EDCs and PPCPs in California waters are, like the national studies, typically less than 10 years old. A few of these studies are highlighted in the following sections.

In 2001 and 2002, a survey of raw and treated drinking water from four water filtration plants in San Diego County showed the occurrence of several PPCPs including phthalate esters, sunscreens, clofibrate, clofribric acid, ibuprofen, triclosan, and DEET (Loraine and Pettigrove 2006). This is important because on average, roughly a third of the water in San Diego County originates from the Delta via conveyances of the SWP. According to the study, occurrence and concentrations of these compounds were highly seasonally dependent, and reached maximums when the flow of the San

Joaquin River was low and the quantity of imported water was high. The maximum concentrations of the PPCPs measured in the raw water were correlated with low flow conditions in the Delta that feed the SWP.

Sampling in the Bay Delta system in 2002 and 2003 resulted in detection of several EDCs and PPCPs (Hoenicke et al. 2007). In this study, the authors reported flame-retardant compounds, pesticides and insecticide synergists, insect repellents, PPCPs, plasticizers, non-ionic surfactants, and other manufacturing ingredients in water, sediment, and/or biological tissue samples. Several of these compounds, especially polybrominated diphenyl ether flame retardants, exhibited concentrations of environmental concern. The highest tissue concentrations of total polybrominated diphenyl ethers in bivalves (oysters, mussels, and clams) were detected in samples near the outlets of the Sacramento and San Joaquin Rivers. Another study evaluated the occurrence and fate and transport of 33 target analytes representing EDCs, PPCPs, and other organic chemicals in wastewater from quarterly samples (i.e., April 2008–2009) collected at eleven locations in the Sacramento River, Delta, and California Aqueduct, along with similar watershed sample locations from the Santa Ana River and imported Colorado River water distribution systems in southern California (Guo et al. 2010). With the exception of the American River sample, all of the Sacramento River/Delta/Aqueduct sample locations had one or more target analytes detected. The median concentration of individual analytes was <30 ng/L, except for diuron (81 ng/L), an agricultural pre-emergent herbicide that is used extensively in the region. Maximum concentrations for some analytes exceeded 100 ng/L. The study determined that analyte concentrations were generally lower in locations upstream of domestic wastewater treatment plants, indicating wastewater effluent discharges as the likely dominant sources of most PPCPs detected.

A preliminary screening study of surface waters along the northern California coastand the Central Valley took place between 2003 and 2005 to determine whether chemicals associated with agricultural and urban land uses could be potential sources of EDCs (de Vlaming et al. 2006). The authors concluded that there was no strong estrogenic activity equivalent to assay positive control.

In 2006, CCWD participated in a study to examine the toxicological relevance of EDCs and PPCPs in both raw source and treated water (Contra Costa Water District 2009). Of the 62 compounds analyzed, only 5 were detected in the treated water: sulfamethoxazole (pharmaceutical), meprobamate (pharmaceutical), atrazine (herbicide – endocrine disruptor), tricolsan (pharmaceutical), and dioctyl phthalate (used to make plastics – endocrine disruptor). The study concluded that detection occurred at low concentrations and should not pose any health threats.

Existing Conditions in the Project Area

Data for most EDCs and PPCPs in the Delta and the north and south of Delta locations are very sparse because most compounds are not typically part of water quality sampling programs. The aforementioned studies represent the most current information on the monitoring of these compounds in the Delta.

Regulatory criteria with respect to emerging pollutants are as follows. Numerical water quality objectives for the CTR, Central Valley Regional Water Quality Control Board Basin Plan, San Francisco Bay Regional Water Quality Control Board Basin Plan, or California drinking water MCLs for certain emerging pollutants that act as EDCs are discussed in previous constituent subsections: mercury, selenium, other trace metals, dioxins, PAHs, PCBs, and pesticides. Listings for emerging pollutants on the Section 303(d) list are limited to these aforementioned subsections as well. With regard to Basin Plan narrative objectives, emerging pollutants might fall under the "population and community ecology" or "toxic" categories.

Recent efforts with respect to emerging contaminants in the project area have focused on developing strategies to assess the problem. For example, State Water Board (2010c) sponsored a report to determine a framework to determine which chemicals of emerging concern to monitor, apply the framework, develop sampling designs/approaches, and establish priorities for future improvements in monitoring/interpretation of chemicals of emerging concern data. Johnson et al. (2010) attempted to relate potential causal mechanisms (chemical, toxicological, histopathologic) to POD in the Bay and the Delta area. The authors found that there were not enough high-quality data available to draw conclusions about potential role of these causal mechanisms in the POD.

8.2 Regulatory Setting

Numerous federal, state and local acts, rules, plans, policies, and programs define the framework for regulating water quality in California. The following discussion focuses on water quality requirements that are applicable to the BDCP. The federal and state agencies responsible for regulating water quality in the project area include.

- USEPA.
- State Water Board.
- San Francisco Bay Regional Water Board.
- Central Valley Water Board.

USEPA provides guidance and oversight to California in regulating water quality, as it does for other states and for tribes. As in other states across the country, USEPA delegates various authorities for establishing water standards and regulating controllable factors affecting water quality to the state. In California, this authority is delegated to the State Water Board. The State Water Board, in turn, delegates authority to its nine regional water boards to implement the state's water quality management responsibilities in the nine geographic regions. Although the state generally takes the lead on developing and adopting water quality standards for California, USEPA must approve new or modified standards. Thus, USEPA, State Water Board, and the two Regional Water Boards cited above have worked together to establish existing water quality standards for the project area. Water quality standards have three components: (1) the beneficial uses of the water to be protected; (2) the water quality criteria (referred to as "objectives" in California) that shall be met to protect the beneficial uses; and (3) an antidegradation policy to protect and maintain water quality when it is better than the criteria/objectives. Additionally, DFG, USFWS, NMFS and the Federal Energy Regulatory Commission impose water quality standards such as DO and temperature in the project area.

8.2.1 Federal Plans, Policies, and Regulations

8.2.1.1 Clean Water Act

The CWA established the basic structure for regulating discharges of pollutants into the waters of the United States and gave USEPA the authority to implement pollution control programs, such as setting wastewater standards for industry. The CWA sets water quality standards for all contaminants in surface waters. The statute employs a variety of regulatory and nonregulatory tools to sharply reduce direct pollutant discharges into waterways, finance municipal wastewater treatment facilities, and manage polluted runoff. The CWA authorizes USEPA to delegate many permitting, administrative, and enforcement aspects of the law to state governments. However, USEPA still retains oversight responsibilities. In California, such responsibility has been delegated to the state, which administers the CWA through State Water Board and the nine Regional Water Boards.

Section 303(d)

Under CWA Section 303(d), states, territories, and authorized tribes are required to develop a ranked list of water-quality limited segments of rivers and other water bodies under their jurisdiction. Listed waters are those that do not meet water quality standards, even after point sources of pollution have installed the minimum required levels of pollution control technology. The law requires that action plans, or TMDLs, be developed to monitor and improve water quality. TMDL is defined as the sum of the individual waste load allocations from point sources, load allocations from nonpoint sources and background loading, plus an appropriate margin of safety. A TMDL defines the maximum amount of a pollutant that a water body can receive and still meet water quality standard. TMDLs can lead to more stringent NPDES permits (CWA Section 402).

In the Delta, the State Water Board and USEPA have approved TMDLs for organic enrichment/low DO and methylmercury in the Delta, and for salt and boron in the San Joaquin River at Vernalis. TMDLs for other constituents remain under planning or development.

Section 401

Under CWA Section 401, applicants for a federal permit or license to conduct activities that may result in the discharge of a pollutant into waters of the United States must obtain certification from the state in which the discharge would originate or, if appropriate, from the interstate water pollution control agency with jurisdiction over affected waters at the point where the discharge would originate. Therefore, all projects that have a federal component and may affect state water quality (including projects that require federal agency approval [such as issuance of a CWA Section 404 permit] must comply with CWA Section 401. In California, the authority to grant water quality certification has been delegated to the State Water Board, and applications for water quality certification are typically processed by the RegionalWater Board with local jurisdiction. Water quality certification requires evaluation of potential effects in light of water quality standards and CWA Section 404 criteria governing discharge of dredged and fill materials into waters of the United States. For the BDCP, water quality certification will be obtained from Central ValleyWater Board.

Section 402

Under CWA Section 402, point- and nonpoint-source discharges to surface waters are regulated through the NPDES program. In California, the State Water Board oversees the NPDES program, which is administered by the Regional Water Boards. The NPDES program provides for both general permits (those that cover a number of similar or related activities) and individual permits.

The NPDES Wastewater Program has responsibility for regulating wastewater discharges to surface waters. Primary program activities include: (1) issuing NPDES permits (new and renewals); (2)

monitoring discharger compliance with permit requirements (review of discharger self-monitoring reports and compliance inspections); (3) taking enforcement action as appropriate; (4) investigating spills and illegal discharges; and (5) handling petitions and litigation.

The NPDES Stormwater Program regulates municipal (Municipal Separate Storm Sewer Systems), construction, industrial, and California Department of Transportation stormwater discharges. Best management practices to control sediment erosion are typically used as part of this program. In general, the stormwater program differs from many other programs in that it uses general permits adopted by the State Water Board. Dischargers that desire coverage under these permits must submit a Notice of Intent to the State Water Board indicating the intent to be covered under the general permit and comply with its requirements. Exceptions to this process include Phase I Municipalities and the California Department of Transportation. Beginning in March 2003, all construction activities with 1 acre of soil disturbance or greater are required to obtain coverage under the General Construction Permit.

Section 404

Under CWA Section 404, a program was established to regulate the discharge of dredged and fill material into waters of the United States, including some wetlands via the issuance of NPDES permits. USACE is authorized to issue Section 404 permits. Activities in waters of the United States that are regulated under this program includefills for development, water resource projects (e.g., dams and levees), infrastructure development (e.g., highways and airports), and conversion of wetlands to uplands for farming and forestry. Under Section 404(b)(1) of the CWA, the Least Environmentally Damaging Practicable Alternative (LEDPA) must be identified from among those alternatives considered in detail in the Environmental Impact Statement (EIS)/Environmental Impact Report (EIR). If a federal agency is a partner in the implementation of a project, then the Proposed Action/Project must be recognized as the LEDPA. A Section 404(b)(1) evaluation will be included with the project's Final EIS/EIR pursuant to the CWA, to provide required information on the potential effects of project activities regarding water quality and to provide rationale in support of identifying the LEDPA. The Draft EIR/EIS will be reviewed by concerned members of the public and stakeholders while given the opportunity to provide comments on project alternatives and documentation.

Construction of the BDCP would be subject to regulation under Sections 401, 402, and/or 404 of the CWA.

8.2.1.2 Rivers and Harbors Act Section 10

Section 10 of the Rivers and Harbors Act of 1899 requires authorization from the U.S. Army Corps of Engineers for the construction of any structure in or over navigable waters of the United States, the excavation/dredging or deposition of material in these waters, or any obstruction or alternation in navigable water.

Construction of the BDCP would be subject to regulation under Section 10 of the Rivers and Harbors Act.

8.2.1.3 Federal Antidegradation Policy

The federal antidegradation policy is designed to provide the level of water quality necessary to protect existing uses and provide protection for higher quality and national water resources. The federal policy directs states to adopt a statewide policy that includes the following primary provisions (40 CFR 131.12).

Existing instream water uses and the level of water quality necessary to protect the existing uses shall be maintained and protected.

1. Where the quality of waters exceed levels necessary to support propagation of fish, shellfish, and wildlife and recreation in and on the water, that quality shall be maintained and protected unless the state finds, after full satisfaction of the intergovernmental coordination and public participation provisions of the state's continuing planning process, that allowing lower water quality is necessary to accommodate important economic or social development in the area in which the waters are located.
2. Where high quality waters constitute an outstanding National resource, such as waters of national and state parks and wildlife refuges and waters of exceptional recreational or ecological significance, that water quality shall be maintained and protected.

8.2.1.4 National Toxics Rule

In 1992, pursuant to the CWA, USEPA promulgated the NTR to establish water quality criteria for 12 states and 2 territories, including California, that had not complied fully with Section 303(c)(2)(B) of the CWA (57 FR 60848). As described in the preamble to the final NTR, when a state adopts and USEPA approves water quality criteria that meet the requirements of Section 303(c)(2)(B) of the CWA, USEPA will issue a rule amending the NTR to withdraw the federal criteria for that state. If the state's criteria are no less stringent than the promulgated federal criteria, USEPA will withdraw its criteria without notice and comment rulemaking because additional comment on the criteria is unnecessary (65 FR 19659). However, if a stateadopts criteria that are less stringent than the federally promulgated criteria, but in USEPA's judgment fully meet the requirements of the CWA, USEPA will provide an opportunity for public comment before withdrawing the federally promulgated criteria (57 FR 60860, December 22, 1992). Amendments to the NTR occurred in May 1995 and November 1999. The CTR (described in a subsequent section) was subsequently promulgated in 2000 and carried forward the established criteria of the NTR, thereby providing a single regulation containing California's adopted and applicable water quality criteria for priority pollutants.

8.2.1.5 Safe Drinking Water Act

The SDWA was established to protect the public health and quality of drinking water in the United States, whether from aboveground or underground sources. The SDWA directed USEPA to set national standards for drinking water quality. It required USEPA to set MCLs for a wide variety of potential drinking water pollutants (Appendix 8A). The owners or operators of public water systems are required to comply with primary (health-related) MCLs and encouraged to comply with secondary (nuisance- or aesthetics-related) MCLs.

SDWA drinking water standards apply to treated water as it is served to consumers. All surface waters require some form of treatment in order to meet drinking water standards. The degree of treatment needed depends on the quality of the raw water. The highest quality raw surface waters need only to be disinfected before being served to consumers. More typically, raw water is treated in a conventional water treatment plant that includes sedimentation, filtration, and disinfection processes. Municipal water suppliers prefer raw water sources of high quality because their use minimizes risk to public health and because their use minimizes the cost and complexity of treatment to meet SDWA drinking water standards.

Some constituents of Delta water are of particular concern to municipal contractors because they are either not removed, only partially removed, or are transformed by the treatment process into hazardous substances by community-used water treatment processes. Constituents of concern include TDS, chlorides, bromides, and organic compounds. These substances can be removed from raw water by advance water treatment processes, but to do so substantially increases the cost borne by municipalities.

8.2.1.6 Surface Water Treatment Rule

The Federal Surface Water Treatment Rule is implemented by the California Surface Water Treatment Rule, which satisfies three specific requirements of the SDWA by: (1) establishing criteria for determining when filtration is required for surface waters; (2) defining minimum levels of disinfection for surface waters; and (3) addressing *Cryptosporidium* spp., *Giardia lamblia*, *Legionella* spp., *E. coli*, viruses, turbidity, and heterotrophic plate count by setting a treatment technique. A treatment technique is set in lieu of an MCL for a contaminant when it is not technologically or economically feasible to measure that contaminant. The Surface Water Treatment Rule applies to all drinking water supply activities in California; its implementation is overseen by DPH.

8.2.1.7 Stage 1 and Stage 2 Disinfectants and Disinfection Byproducts Rule and Long-Term 1 and Long-Term 2 Enhanced Surface Water Treatment Rule

The Stage 1 Disinfectants and Disinfection Byproducts (D/DBP) Rule established maximum residual disinfectant level goals and maximum residual disinfectant levels for chlorine, chloramines, and chlorine dioxide. It also set MCL goals and MCLs for trihalomethanes, five HAAs, chlorite, and bromate. The primary purpose of the Long-Term 1 Enhanced Surface Water Treatment Rule is to improve microbial control, especially for *Cryptosporidium*

Water systems that use surface water and conventional filtration treatment are required to remove specified percentages of organic materials, measured as TOC, which may react with disinfectants to form DBPs. Removal is to be achieved through a treatment technique (e.g., enhanced coagulation or enhanced softening), unless the system meets alternative criteria.

USEPA adopted the Stage 2 Microbial and Disinfection Byproducts Rules in January 2006. The Rules include both the Stage 2 Disinfectants and Disinfection Byproducts Rule and Long-Term 1, and Long-Term 2 Enhanced Surface Water Treatment Rule. These rules include revised and new requirements, such as water systems having to meet DBP MCLs at each monitoring site in the distribution system, rather than averaging multiple sites. The rules also contain a risk-targeting approach to better identify monitoring sites where customers are exposed to high levels of DBPs. The rules include new requirements for treatment efficacy and *Cryptosporidium* inactivation/ removal, as well as new standards for DBPs, disinfectants, and potential contaminants.

The overall goal of this group of regulations is to balance the risks from microbial pathogens with those from carcinogenic DBPs. All domestic water suppliers must follow the requirements of these rules, which are overseen by DPH.

8.2.2 State Plans, Policies, and Regulations

8.2.2.1 Porter-Cologne Water Quality Control Act of 1969

Under the Porter-Cologne Water Quality Control Act, water quality objectives are limits or levels of water quality constituents or characteristics established for the purpose of protecting beneficial uses. The Act requires the Regional Water Quality Control Boards to establish water quality objectives necessary to reasonably protect a water body's beneficial uses. Designated beneficial uses, together with the corresponding water quality objectives, also constitute water quality standards under the CWA. Therefore, the water quality objectives form the regulatory references for meeting state and federal requirements for water quality control.

A change in water quality is allowed only if the change is consistent with the maximum beneficial use of the waters of the state, would not unreasonably affect the present or anticipated beneficial uses, and would not result in water quality lower than that specified in applicable WQCPs (Central Valley Regional Water Quality Control Board 2009a). Many aspects of the BDCP would be subject to the Porter-Cologne Water Quality Control Act.

8.2.2.2 State Water Resources Control Board Water Rights Decisions, Water Quality Control Plans, and Water Quality Objectives

The preparation and adoption of WQCPs is required by the California Water Code (Section 13240) and supported by the CWA. Section 303 of the CWA requires states to adopt water quality standards that "consist of the designated uses of the navigable waters involved and the water quality criteria for such waters based upon such uses." According to Section 13050 of the California Water Code, WQCPs consist of a designation or establishment for the waters within a specified area of beneficial uses to be protected, water quality objectives to protect those uses, and a program of implementation needed for achieving the objectives. Beneficial uses are defined in Water Code Section 13050(f) as including domestic, municipal, agricultural, and industrial supply; power generation; recreation; aesthetic enjoyment; navigation; and the preservation and enhancement of fish, wildlife, and other aquatic resources or preserves. Because beneficial uses, together with their corresponding water quality objectives, can be defined per federal regulations as water quality standards, the WQCPs are regulatory references for meeting the state and federal requirements for water quality control. One substantial difference between the state and federal programs is that California's WQCPs establish standards for groundwater in addition to surface water. Adoption or revision of surface water standards is subject to the approval of USEPA.

The State Water Board is responsible for protecting, where feasible, the state's public trust resources, including fisheries and has the authority under Article X, Section 2 of the California Constitution and Water Code Section 100 to prevent the waste or unreasonable use, unreasonable method of use, or the unreasonable method of diversion of all waters of the state.

The State Water Board Water Rights Division has primary regulatory authority over water supplies and issues permits for water rights—specifying amounts, conditions, and construction timetables—

for diversion and storage facilities. Water rights decisions implement the objectives adopted in the Delta WQCP and reflect water availability, recognize prior water rights and flows needed to preserve instream uses (such as water quality and fish habitat), and whether the diversion of water is in the public interest.

WQCPs adopted by Regional Water Quality Control Boards are primarily implemented through the NPDES permitting system and issuance of waste discharge requirements to regulate waste discharges so water quality objectives are met. Basin plans provide the technical basis for determining waste discharge requirements and authorize the Regional Water Quality Control Boards to take regulatory enforcement actions if deemed necessary.

8.2.2.3 Water Quality Control Plan for the San Francisco Bay/Sacramento–San Joaquin Delta Estuary

The current WQCP in effect in the Delta is the *2006 Water Quality Control Plan for the San Francisco Bay/Sacramento–San Joaquin Delta Estuary* (Bay-Delta WQCP) (State Water Resources Control Board 2006). The WQCP identifies beneficial uses of water in the Delta to be protected, water quality objectives for the reasonable protection of beneficial uses, and an implementation program to achieve the water quality objectives.

The 2006 WQCP adoption did not involve substantial changes to the prior 1995 WQCP. The 1995 WQCP was developed as a result of the December 15, 1994, Bay Delta Accord, which committed SWP and CVP to new Delta habitat objectives. The new objectives were adopted by amendment through a water rights decision (D-1641) for SWP and CVP operations. One key feature of the 1995 WQCP is the estuarine habitat objectives ("X2") for Suisun Bay and the western Delta. The X2 standard refers to the position at which 2 ppt salinity occurs in the Delta estuary, and is designed to improve shallow water fish habitat in the spring of each year. The X2 standard requires specific daily or 14-day salinity, or 3-day averaged outflow requirements, to be met for a certain number of days each month from February through June.

Other elements of the WQCP include export-to-inflow ratios intended to reduce entrainment of fish at the export pumps, Delta Cross Channel gate closures, minimum Delta outflow requirements, and San Joaquin River salinity and flow standards.

8.2.2.4 Water Quality Control Plan (Basin Plan) for the Sacramento and San Joaquin River Basins

The Basin Plan for the Central Valley Regional Water Quality Control Board covers an area including the entire Sacramento and San Joaquin River basins, involving an area bound by the crests of the Sierra Nevada on the east and the Coast Range and Klamath Mountains on the west. The area covered in this WQCP extends some 400 miles, from the California-Oregon border southward to the headwaters of the San Joaquin River. The BDCP will be required to meet the water quality objectives in the Basin Plan for the Sacramento and San Joaquin River basins, which was designed to protect the beneficial uses of the Sacramento and San Joaquin Rivers and their tributaries, and was last amended in 2009 (Central Valley Regional Water Quality Control Board 2009a).

8.2.2.5 San Francisco Bay Basin Water Quality Control Plan (Basin Plan)

The Basin Plan covers 1,100 square miles of the 1,600 square-mile San Francisco Bay Estuary and includes coastal portions of Marin and San Mateo counties, from Tomales Bay in the north to Pescadero and Butano Creeks in the south. The Bay system functions as the only drainage outlet for waters of the Central Valley. It also marks natural topographic separation between the northern and southern coastal mountain ranges. The region's waterways, wetlands, and bays form the centerpiece of the fourth-largest metropolitan region in the United States, and includes all or major portions of Alameda, Contra Costa, Marin, Napa, San Francisco, San Mateo, Santa Clara, Solano, and Sonoma counties.

8.2.2.6 State Water Board Resolution No. 68-16 - Statement of Policy with Respect to Maintaining High Quality Waters in California (State Antidegradation Policy)

The goal of State Water Board Resolution No. 68-16 ("Statement of Policy With Respect to Maintaining High Quality Waters in California") is to maintain high quality waters where they exist in the state. State Board Resolution No. 68-16 states, in part:

1. Whenever the existing quality of water is better than the quality established in policies as of the date on which such policies become effective, such existing high quality will be maintained until it has been demonstrated to the state that any change will be consistent with maximum benefit to the people of the state, will not unreasonably affect present and anticipated beneficial use of such water and will not result in water quality less than that prescribed in the policies.
2. Any activity which produces or may produce a waste or increased volume or concentration of waste and which discharges or proposes to discharge to existing high quality waters will be required to meet waste discharge requirements which will result in the best practicable treatment or control of the discharge necessary to assure that (a) a pollution or nuisance will not occur and (b) the highest water quality consistent with maximum benefit to the people of the state will be maintained.

The State Water Board has interpreted Resolution No. 68-16 to incorporate the federal antidegradation policy, which is applicable if a discharge that began after November 28, 1975, will lower existing surface water quality.

8.2.2.7 Water Quality Control Plan for the Control of Temperature in the Coastal and Interstate Waters and Enclosed Bays and Estuaries of California (Thermal Plan)

The Thermal Plan sets limits for "thermal waste" and "elevated temperature waste" discharged into coastal and interstate waters and enclosed bays and estuaries of California (State Water Resources Control Board 1975). The Thermal Plan also empowers Regional Water Boards, with State Water Board's concurrence, to grant a discharger exceptions from the plan's specific water quality objectives. Estuarine waters are considered to extend from "… a bay or the open ocean to the upstream limit of tidal action."

Objective 5A(1)a of the Thermal Plan prohibits a waste discharge to estuaries that exceeds the natural receiving water temperature by more than 20ºF. Objective 5A(1)b prohibits a waste discharge that would cause more than a 1ºF (0.56ºC) rise in more than 25% of the receiving water cross-section at the discharge location. Objective 5A(1)c states that no discharge shall cause a surface water temperature rise of more than 4ºF above the natural receiving water temperature at any time. State Water Resources Control Board Sources of Drinking Water Policy (Resolution No. 88-63)

The Sources of Drinking Water Policy established state policy that all waters, with certain exceptions, should be considered suitable or potentially suitable for municipal or domestic supply. Under the policy, unless otherwise designated, Regional Water Boards must consider all surface and groundwaters as suitable, or potentially suitable, for municipal or domestic water supply. The policy defines the following three categories of waters potentially eligible for an exception from the designation and protection of a water source for municipal/domestic supply.

- Water bodies with high salinity (i.e., defined as TDS >3,000 mg/L), and either have naturally high contaminant levels that cannot reasonably be treated using either Best Management Practices or best economically achievable treatment practices, or produce too low yield (<200 gallons per day).
- Waters designed or modified to treat wastewaters (i.e., domestic or industrial wastewater, process water, stormwater, mining discharges, or agricultural drainage), provided that such systems are monitored to assure compliance with all relevant water quality objectives.
- Groundwater aquifers regulated as geothermal energy producing sources or aquifers that have been exempted administratively by federal regulations for the purpose of underground injection of fluids associated with the production of hydrocarbon or geothermal energy.

8.2.2.8 Policy for Implementation and Enforcement of the Nonpoint Source Pollution Control Program [Water Code Section 13369(a)(2)(B)]

Agricultural return flows include flows from tile drains and irrigation and stormwater runoff. These discharges can affect water quality by transporting pollutants, including pesticides, sediments, and nutrients, from cultivated fields into surface water. Many surface water bodies are impaired because of pollutants from agricultural sources. Groundwater bodies within California's agricultural areas have also suffered pesticide, nitrate, and salt contamination.

Historically, most Regional Water Quality Control Boards regulated these discharges under waivers, as authorized by Water Code Section 13269, and other administrative tools were seldom used. Section 13269 allows the Regional Water Quality Control Boards to waive the requirement for waste discharge requirements if it is in the public interest. Although waivers were always conditional, the historical waivers had few conditions. In general, they required that discharges not cause violations of water quality objectives, but did not require water quality monitoring.

In May 2004, the State Water Board adopted a new policy regulating nonpoint source pollution, known as the Policy for Implementation and Enforcement of the Nonpoint Source Pollution Control Program, fulfilling the requirements of Water Code Section 13369(a)(2)(B). This policy affects landowners and operators throughout the state engaged in agricultural production, timber harvest operations, and other potential sources of nonpoint source pollution.

The 2004 policy generally expects nonpoint source dischargers to use management practices that do not impair surface water quality and charges each landowner a fee to cover increased regulatory oversight. Consequently, implementation programs for nonpoint source pollution control have expanded beyond waivers and may now be developed by a Regional Water Board, the State Water Board, individual dischargers, or by a coalition of dischargers in cooperation with a third-party representative, organization, or government agency. The latter programs are collectively known as "third-party" programs, and the third-party role is restricted to entities that are not actual dischargers under Regional Water Board/State Water Board point-discharge permitting and enforcement jurisdiction.

8.2.2.9 California Toxics Rule

As a result of a court-ordered revocation of California's statewide WQCP for priority pollutants in September 1994, USEPA initiated efforts to promulgate additional numeric water quality criteria for California. In May 2000, USEPA issued the CTR that promulgated numeric criteria for priority pollutants not included in the NTR. The CTR documentation (65 Federal Register 31682, May 18, 2000) carried forward the previously promulgated standards of the NTR, thereby providing a single document listing California's adopted and applicable water quality criteria for priority pollutants.

8.2.2.10 Policy for the Implementation of Toxics Standards for Inland Surface Waters, Enclosed Bays, and Estuaries of California

In March 2000, the State Water Board adopted the Standards for Inland Surface Waters, Enclosed Bays, and Estuaries of California (SIP), which implemented criteria for priority toxic pollutants contained in the CTR, as well as other priority toxic pollutant criteria and objectives. The SIP applies to discharges of toxic pollutants into inland surface waters, enclosed bays, and estuaries of California subject to regulation under the state's Porter-Cologne Water Quality Control Act (Division 7 of the Water Code) and the federal CWA. Such regulation may occur through the issuance of NPDES permits or other relevant regulatory approaches. The goal of this policy is to establish a standardized approach for permitting discharges of toxic pollutants to nonocean surface waters in a manner that promotes statewide consistency. As such, SIP is a tool to be used in conjunction with watershed management approaches and, where appropriate, the development of TMDLs to ensure achievement of water quality standards (i.e., water quality criteria or objectives and the beneficial uses they are intended to protect, as well as the state and federal antidegradation policies).

SIP established: (1) implementation provisions for priority pollutant criteria promulgated by USEPA through the NTR and CTR and for priority pollutant objectives established by Regional Water Quality Control Boards in their WQCPs; (2) monitoring requirements for 2,3,7,8-TCDD equivalents; and (3) chronic toxicity control provisions. In addition, the SIP includes special provisions for certain types of discharges and factors that could affect the application of other provisions in the policy.

8.2.2.11 Department of Public Health Safe Drinking Water Act Implementation

DPH is designated by USEPA as the primary agency to administer and enforce requirements of the federal SDWA in California. Public water systems are required to monitor for regulated contaminants in their drinking water supply. California's drinking water standards (e.g., MCLs) are the same or more stringent than the federal standards and include additional contaminants not regulated by USEPA. Like the federal MCLs, California's primary MCLs address health concerns, while secondary MCLs address aesthetics, such as taste and odor. The California SDWA is administered by DPH primarily through a permit system.

8.2.2.12 State Water Resources Control Board Decision 1641 (D-1641)

The Bay-Delta WQCP (discussed previously) outlines current water quality objectives for the Delta. State Water Board D-1641 contains the current water right requirements, applicable to DWR and Reclamation's operations of the SWP and CVP facilities, respectively, to implement the Bay Delta water quality objectives. D-1641 specifies that, from February through June, the location of X2 must be west of Collinsville and must additionally be west of Chipps Island or Port Chicago for a certain number of days each month, depending on the previous month's Eight River Index. D-1641 specifies that compliance with the X2 standard may occur in one of three ways: (1) the daily average EC at the compliance point is less than or equal to 2.64 millimhos/cm; (2) the 14-day average EC is less than or equal to 2.64 millimhos/cm; or (3) the 3-day average Delta outflow is greater than or equal to the corresponding minimum outflow.

In D-1641, the State Water Board assigned responsibilities to Reclamation and DWR for meeting these requirements on an interim basis. These responsibilities required that SWP and CVP be operated to meet water quality objectives in the Delta, pending a water rights hearing to allocate the obligation to meet the water quality and flow-dependent objectives among all users of the Sacramento and San Joaquin River basins with appropriative water rights with post-1914 priority dates. However, in lieu of this hearing, the San Joaquin River Agreement and Sacramento Valley Water Management Agreement are settlements between Reclamation and DWR with upstream of the Delta water users, in which SWP and CVP committed to continue to meet the D-1641 water quality requirements in return for other commitments by major upstream water-rights holders. After these agreements were executed, the State Water Board cancelled the water rights hearing to allocate that responsibility.

In February 2006, the State Water Board issued a Cease and Desist Order (CDO, Water Rights Order No. 2006-0006) to DWR and Reclamation which established actions and a compliance schedule for implementation of the requirements contained in D-1641, in particular to ensure compliance with the salinity objectives for the interior southern Delta. The CDO also revised the previously issued (July 1, 2005) Water Quality Response Plan approval governing Reclamation's and DWR's Joint Point of Diversion (JPOD) operations (i.e., use of the other agency's respective point of diversion in the southern Delta). The CDO specified that the agencies may conduct JPOD operations provided that both agencies are in compliance with all of the conditions of their respective water right permits and licenses at the time that the JPOD operations would occur. The CDO was amended in January 2010 (Water Rights Order No. 2010-0002) to modify the time schedule of actions to follow the State Water Board's next review of the 2006 Bay-Delta WQCP and separate hearings completed in 2010 for the consideration of changes to the interior southern Delta salinity objectives.

D-1641 also established the Vernalis Adaptive Management Plan, a 12-year experimental/adaptive management program to assess effects of changes in flows and aquatic habitat resources on juvenile Chinook Salmon migrating from the San Joaquin River through the Delta. More detailed discussion on this plan and the adaptive management process is included in Chapter 11, *Fish and Aquatic Resources*. This plan will expire after 2011.

SWP and CVP Coordinated Operations Agreement

SWP and CVP are relatively independent projects that use a common water supply. In 1986, Public Law 99-546 authorized the Coordinated Operations Agreement (COA) between the Reclamation and DWR, intended to define the rights and responsibilities of SWP and CVP with respect to use of that common water supply, and provide an infrastructure to monitor those rights and responsibilities. Specifically, the COA defines the project facilities and their water supplies, sets forth procedures for coordination of operations, identifies formulas for sharing joint responsibilities for meeting Delta flow and water quality standards and other legal uses of water, identifies how unstored flow will be shared, sets up a framework for exchange of water and services between the projects, and provides for periodic review every 5 years (Bureau of Reclamation 2004).

Although implementation of the COA has changed since 1986 as modifications have occurred to the SWP and CVP systems and the operations of those systems have been altered, revisions to the 1986 COA have not been implemented to reflect changes in regulatory standards, operating conditions, and new project features, such as the Environmental Water Account (EWA).

SWP and CVP Project Water Acceptance Criteria

In consultation with SWP contractors and DHS, DWR developed acceptance criteria to govern the water quality of nonproject water conveyed through the California Aqueduct. Non-project water with chemical concentrations less than the acceptable criteria is routinely accepted by DWR. Non-project water with chemical concentrations greater than the criteria is managed on a case-by-case basis.

8.2.2.13 Central Valley Regional Water Quality Control Board Drinking Water Policy

A commitment of the CALFED Bay-Delta Program process and Record of Decision was the development of a new drinking water policy for Delta waters. Currently, both the Bay-Delta WQCP and the Sacramento-San Joaquin Basin Plan lack numeric water quality objectives for several known drinking water constituents of concern, such as organic carbon and pathogens (CALFED Bay-Delta Program 2008b). In response to the CALFED commitment, Central Valley Regional Water Quality Control Board is in the process of a multiyear effort to develop a drinking water policy for surface waters in the Central Valley (Central Valley Regional Water Quality Control Board 2011). Existing policies and plans lack water quality objectives for several known drinking water constituents of concern, including DBP precursors and pathogens, and also lack implementation strategies to provide effective source water protection. The new policy will culminate in the incorporation of new requirements into a Basin Plan amendment, anticipated to be completed in 2013. The Central Valley Regional Water Quality Control Board Drinking Water Policy will apply to Delta waters and any activities, such as discharges, that affect Delta water quality.

8.2.3 Nonregional and Local Plans, Policies, and Regulations

The principal local regulatory requirements for surface water quality protection at the local governmental agency level consist of stormwater management programs to implement their responsibilities under the statewide NPDES stormwater permits for Municipal Separate (MS) Storm Sewer System adopted by the State Water Board. Larger entities such as the core municipal areas of

Sacramento and Stockton are regulated under individual permits (MS1 permits), whereas smaller cities and unincorporated areas are typically regulated by the State Water Board's MS4 permit. Entities must prepare Storm Water Management Plans (SWMPs) for the permits that outline the agency actions that will be conducted to reduce the discharge of pollutants from storm drainage systems. The SWMPs must address urban runoff and construction site runoff. Additional County implementing code and regulations for water quality protection typically include grading permits, erosion and sediment control ordinances, and stormwater drainage facility design and management requirements.

8.3 Environmental Consequences

This section describes potential direct (both temporary construction-related and permanent operations-related) and indirect effects on water quality within the affected environment that would result from implementation of each alternative. An analysis of the consistency of the alternatives with applicable state water quality standards, plans, and policies, including the federally promulgated National Toxics Rule (NTR) and CTR, is provided for the Upstream of the Delta Region, Delta Region, and the SWP and CVP Export Service Areas Region of the affected environment. The impact analysis separates temporary construction-related impacts from those associated with long-term facilities operations for the alternatives. Each of the alternatives' proposed features are divided into two categories; physical/structural components associated with the new conveyance facilities and their operations (CM1), which are project-level features and restoration actions or "conservation measures" (CM2–CM22), which are programmatic features.

8.3.1 Methods for Analysis

Each Alternative would consist of two broad categories of actions, which are: (1) short-term construction activities, and (2) numerous conservation measures. The conservation measures are further characterized by the following four major components.

1. New north Delta diversion and conveyance facilities to be operated in conjunction with SWP and CVP existing facilities (collectively called *conveyance*).
2. Detailed criteria that will govern the operations of the SWP and CVP conveyance system across a range of hydrological conditions (collectively called operations). Number 1 and 2 together are referred to as conservation measure (CM) 1.
3. Habitat Restoration: each action alternative would include a range of tidal marsh, floodplain, riparian, and upland transition habitat activities within the Plan Area. (CM2–CM11).
4. Actions to address and control contaminants, nonnative invasive species, and predation, and to address other potentially important non-conveyance and non-habitat-related stressors on covered species (collectively called *other stressors*) (CM12–CM22).

Implementation of the alternatives would result in changes to SWP and CVP facilities and operations, Delta habitats, and Delta hydrodynamics (i.e., how water moves through the Delta). Other conservation measure also could directly affect water quality positively or negatively at certain locations. Thus, the components of the Alternatives could collectively result in complex water quality changes within the affected environment (see Section 8.1). For the purposes of this assessment, the project area is divided into the three regions (Figure 8-9, Figure 8-10, and Figure 8-11).

- Plan Area, including the Yolo Bypass, SWP North Bay Aqueduct service area, and Suisun Marsh.
- Upstream of the Delta (including the Sacramento and San Joaquin River watersheds).
- SWP/CVP Export Service Area (south of the Delta, areas served by the California Aqueduct, Delta Mendota Canal, and South Bay Aqueduct [SBA]).

The two key questions to be addressed by this surface water quality impact assessment are as follows.

1. Would implementation of the Alternatives result in water quality changes to the Plan Area, Upstream of the Delta, or SWP/CVP Export Service Areas of sufficient frequency, magnitude, and geographic extent as to cause or substantially contribute to significant adverse impacts on the beneficial uses of water in these areas of the affected environment?
2. What would be the beneficial effects on water quality in these areas?

Appropriately addressing these questions is a complex task because:

- The full effects of the Alternatives would occur in the future, and "project effects" on water quality involve numerous constituents of interest (many having adopted water quality objectives/criteria and some without adopted objectives/criteria).
- Multiple beneficial uses could be affected by changes in water quality.
- Numerous locations of interest are found throughout the large affected environment.

Moreover, models available for use in addressing such questions have been previously developed for the effects of operations of the SWP-CVP facilities for only a few water quality parameters (e.g., electrical conductivity [EC], dissolved organic carbon [DOC], and temperature) in defined portions of the affected environment (i.e., the Delta), and are poorly developed or not developed at all for nearly all other water quality parameters and locations, nor for most of the conservation measures proposed for implementation. Consequently, the methodology developed for assessing water quality impacts differed for each of the three areas of the affected environment because:

- The beneficial uses of water in each area are affected differently by the Alternatives.
- Each area has different constituents of concern and different historical data availability for those constituents.
- The availability of models that can be used to support quantitative assessments differs in each area.

Hence, a combination of both quantitative and qualitative analyses (as appropriate) was performed to estimate the changes in water quality attributable to implementation of the Alternatives within the three areas of the affected environment. Depending on the constituent and location, these changes could be significant/adverse (e.g., increase in concentration or mass loading of harmful constituents), insignificant, or beneficial.

In general, the fewest water quality changes of importance are expected to occur Upstream of the Delta, followed by the SWP/CVP Export Service Areas, with the greatest number and magnitude of water quality changes expected for the Plan Area. The Plan Area was analyzed in the greatest detail for the following reasons.

- Its water quality would be most affected by the BDCP action alternatives.
- It has complex hydrodynamic characteristics.
- Models are available to simulate hydrodynamic and water quality changes within the Delta region.
- Delta water quality is critically important to the water supplies of California residents that use water within the Delta and in the SWP/CVP Export Service Areas.

All constituents for which data were compiled were run through an initial screening analysis that determined the appropriate levels of analysis needed for each constituent, and whether further analysis beyond that provided by the screening analysis itself, if needed, would be qualitative or quantitative. The details of the screening analysis are discussed later in this section.

The constituents of concern in the affected environment included both physically and chemically conservative and non-conservative parameters. The concentrations of conservative constituents tend to not be affected substantially by physical, chemical, or biological mechanisms that would result in a loss of the constituent from the system. Thus, the concentrations of conservative constituents can be reasonably estimated and changes assessed with mass-balance accounting of the mixing of known volumes and concentrations of different water sources. Non-conservative constituents can be affected by mechanisms that result in loss from the water such as physical (e.g., settling, volatilization), chemical (e.g., adsorption, oxidation-reduction, complexation), or biological (e.g., uptake, decay) mechanisms such that mass-balance accounting becomes much more complex. Historical monitoring data for the majority of these constituents were collected and reviewed from various locations of interest within the affected environment.

Conservative parameters were evaluated using available models used for SWP-CVP planning and operations (i.e., California Water Resources Simulation Model [CALSIM II, Delta Simulation Model 2 [DSM2], and the Bureau of Reclamation's [Reclamation] Temperature Model) wherever applicable, as well as constituents directly addressed by these models, and included EC, DOC, and temperature. It should be noted that because aquatic life beneficial uses are the only uses expected to be affected by temperature changes under the various Alternatives, the water quality chapter cross-references to the Fisheries and Aquatic Resources chapter for all impact assessments for temperature.

These models produce detailed estimates of existing and future flow and water quality conditions for the major reservoir, river, Delta, and constructed features such as agricultural diversions, municipal diversions, and associated conveyance facilities within the project area. As such, the CALSIM and DSM2 model outputs also were used to support quantitative mass-balance assessments for several other constituents that exhibit generally conservative characteristics (i.e., boron, bromide, chloride, mercury, selenium, and sulfate). Non-conservative parameters such as DO, nutrients, heavy metals, pesticides, polychlorinated biphenyls, etc., were evaluated qualitatively. Detailed discussion on when and where qualitative or quantitative analyses were performed is included later in this section.

Mercury and selenium were analyzed in detail because of their bioaccumulative properties. Bioaccumulation refers to the uptake of a constituent by a biological organism which exceeds the excretion or loss from the organism, such that concentrations within the organism are increased over time. The specific methodologies used to evaluate these two parameters are discussed separately in this section. Various models used in analyzing these constituents of interest and their interrelationship have also been discussed in detail.

Based on the components of the Alternatives (described previously in this section), three categories of potential changes in water quality conditions are described, as follows.

- Changes attributable to construction activities.
- Changes attributable to operations and maintenance of new conveyance facilities and new SWP and CVP operational criteria (CM1).
- Changes attributable to implementation of other defined conservation measures (CM2–CM22).

It was determined that the action alternatives would result in all three categories of potential water quality effects within the Plan Area. However, based on the description of BDCP alternatives (see Chapter 3) for the Upstream of the Delta Region and the SWP/CVP Export Service Areas, changes attributable to construction activities or other conservation measures were expected to be minimal and, hence, are not addressed in as much detail.

The frequency, magnitude, and geographic extent of any change in specific water quality constituents, or change in mass loading, is of primary importance in determining effects on beneficial uses (aquatic biology, municipal and domestic supply, agricultural uses, recreation, etc.). Consequently, findings regarding estimated concentrations at each assessment location for individual constituents of concern under the alternatives were compared to thresholds of significance (Section 8.3.2) for the purposes of making California Environmental Quality Act (CEQA) and National Environmental Policy Act (NEPA) impact determinations. Thresholds of significance define the criteria used to define the level at which an impact would be considered significant in accordance with CEQA and NEPA. Thresholds were based on the checklist in Appendix G of the CEQA Guidelines (CCR, Title 14, Division 6, Chapter 3), scientific information and data, and regulatory standards. These thresholds take into account the factors under NEPA to determine the significance of an action in terms of the context and intensity of its effects (40 CFR 1508.27).

If the estimated water quality conditions for a constituent under the Alternatives trigger one or more of the four water quality thresholds of significance at one or more of the assessment locations, then the Alternatives were determined to have a significant adverse impact on that water quality constituent or parameter and mitigation measures were recommended for CEQA purposes to minimize the significant adverse impacts.

In summary, the impact assessment methodology includes the following.

1. Addressed all constituents of concern based on available information and the current science regarding concentrations/levels that would adversely affect beneficial uses of waters within the affected environment.
2. Quantitatively evaluated constituents of primary concern where modeling tools were developed and were available for doing so, and made qualitative assessments where appropriate modeling tools were unavailable.
3. Evaluated the overall effect of the Alternatives on beneficial uses in a comparative manner throughout the affected environment, during three distinct time frames (see Section 8.3.1), which addressed climate change considerations.

The details of this methodological approach are discussed below. In the following sections, the specific methodologies used to assess water quality impacts within the three distinct areas of the affected environment (i.e., Upstream of the Delta, Plan Area, and SWP/CVP Export Service Areas) are discussed.

8.3.1.1 Models Used and their Linkages

The models used in support of the quantitative water quality analyses were: (1) Reclamation's and California Department of Water Resources' (DWR) CALSIM II hydrologic model; (2) DWR's DSM2; and (3) Reclamation's River Temperature models. A brief description of each model is provided below, followed by a discussion of how the results from these models were used to quantify changes in water quality constituent concentrations/parameter levels.

The CALSIM II model, which has been jointly developed and maintained by DWR and Reclamation to provide hydrologic-based information for planning, managing, and operating the integrated SWP and CVP system, was used to simulate system operations and resulting hydrologic conditions under the Alternatives. CALSIM II operates on a monthly time step from water year 1922 through 2003. Using historical rainfall and runoff data, which have been adjusted for changes in water and land use that have occurred or are projected to occur in the future. The model simulates the operation of the SWP and CVP system on a month-to-month basis for the 82-year hydrologic period of record. In the model, the reservoirs and pumping facilities of the SWP and CVP are operated to ensure the flow and water quality requirements for these systems are met. The model assumes that facilities, land use, water supply contracts, and regulatory requirements are constant throughout the 82-year hydrologic period of record, thus providing a simulation representing a fixed level of development.

Among other output, CALSIM II provides mean monthly output for reservoir storage levels, reservoir releases, flows at various locations along the major rivers, X2 location, Delta inflow, and Delta outflow for an 82-year hydrologic period of record. The primary linkage of these models is for CALSIM II output to serve as input to the DSM2 model and the Reclamation temperature models, as shown in Figure 8-57. Input assumption details for each scenario modeled using CALSIM II are provided in Appendices 4A and 5A.

DSM2 is a one-dimensional mathematical model for dynamic simulation of hydrodynamics, water quality, and particle tracking throughout the Delta. DSM2 can be used to calculate stages, flows, velocities, mass transport processes for conservative constituents, and transport of individual particles. The model runs on a 15-minute time step for a 16-year (1976–1991) hydrologic period of record. DSM2 currently consists of three modules: HYDRO, QUAL, and PTM. HYDRO simulates one-dimensional hydrodynamics including flows, velocities, depth, and water surface elevations. HYDRO provides the flow input for QUAL and PTM. QUAL simulates one-dimensional fate and transport of conservative water quality constituents given a flow field simulated by HYDRO. PTM simulates pseudo three-dimensional transport of neutrally buoyant particles based on the flow field simulated by HYDRO. Input assumption details for each scenario modeled are provided in Appendices 4A and 5A.

CALSIM II output provides the hydrologic input to the temperature models for an 82-year hydrologic period of record (1922–2003). The temperature models consist of two basic model types: a reservoir model and a river model. Reclamation developed reservoir temperature models for Trinity Lake, Whiskeytown Reservoir, Shasta Lake, Folsom Lake, New Melones Lake, and Tulloch Reservoir. The reservoir models are used to simulate one-dimensional, vertical distribution of reservoir water temperature using monthly input data on initial storage and temperature conditions, inflow, outflow, evaporation, precipitation, radiation, and average air temperature. Temperatures in the downstream regulating reservoirs—Lewiston, Keswick, Natomas, and Goodwin—are computed from equilibrium temperature decay equations in the reservoir models, which are similar to the river model equations.

The river temperature models output mean monthly temperatures at 3 locations on the Trinity River from Lewiston Dam to the North Fork, 9 locations on the American River from Nimbus Dam to the mouth, and 8 locations on the Stanislaus River from Goodwin Dam to the mouth. The Sacramento River Water Quality Model simulates reservoir and river temperatures on a daily average basis and provides average monthly river temperature values for 12 locations on the Sacramento River from Keswick Dam to Freeport. The models are one-dimensional in the longitudinal direction and assume fully-mixed river cross sections. The effect of tributary inflow on river temperature is computed by mass-balance calculation. The river temperatures are based on regulating reservoir release temperatures, river flows, and climatic data. While there are some limitations based on assessments at a relatively coarse monthly average time step, the models are adequate as planning tools to compare the relative temperature effects that would occur from implementation of different Alternatives.

8.3.1.2 Upstream of the Delta Region

Water quality changes in the affected environment upstream from the north-Delta boundary, which includes the Sacramento River to Shasta Lake, the Feather River to Lake Oroville, and the American River to Folsom Lake, were primarily assessed qualitatively. Assessment of water quality changes was limited to operations-related water quality changes and the implementation of CM2–CM22. Conveyance facility construction-related effects are not anticipated upstream of the Delta.

The assessment of water quality changes in water bodies upstream of the Delta relied, in part, on making determinations as to how reservoir storage and releases would be changed. Specific changes in reservoir storage and releases were determined from CALSIM II modeling of the SWP and CVP system (Appendices 4A and 5A describe the CALSIM II modeling performed in support of this assessment). Reservoir storage and river flow changes were then evaluated to make determinations regarding the capacity for the affected water bodies to provide dilution of watershed contaminant inputs. Also, if a particular parameter was found to be correlated to seasonal reservoir levels or river flows, how the parameter would be altered seasonally by operational changes in reservoir levels or river flows was assessed.

8.3.1.3 Plan Area

Water quality changes in the Delta were assessed quantitatively to the extent that data and models were available to do so; otherwise, water quality changes were assessed qualitatively. Using the methodology described below, changes in boron, bromide, chloride, mercury, organic carbon, selenium, and sulfate within the Delta were determined quantitatively at 11 assessment locations (Figure 8-9), while electrical conductivity was assessed at D-1641 compliance locations. Operations-related water quality changes would be partly driven by geographic and hydrodynamic changes resulting from restoration actions (i.e., altered hydrodynamics attributable to new areas of tidal wetlands (CM4), for example). To the extent that restoration actions affect altered hydrodynamics within the Delta region, these effects were included in the modeling assessment of operations-related water quality changes. Methodologies to determine the effects attributable to construction activities and actions to address the other stressors are discussed later in this section (Figure 8-58).

Constituent Screening Analysis

Constituents assessed in the water quality chapter were identified based on the following considerations.

- Availability of historical monitoring data.
- Constituents having adopted federal water quality criteria or state water quality objectives.
- Constituents on the state's CWA Section 303(d) list in the Delta.
- Constituents identified in public scoping comments.
- Constituents deserving assessment based on professional judgment.

A constituent *screening analysis* was conducted on 182 water quality constituents/parameters. The screening analysis determined which constituents had no potential to exceed the thresholds of significance by implementation of the Alternatives and, thus, did not warrant further assessment. This analysis identified a list of "constituents of concern" that were further analyzed as part of assessing their potential water quality related impacts under the Alternatives. For a detailed description of the approach employed in the constituent screening analysis, see Appendix C.

Determining Whether Assessment is Qualitative or Quantitative

For many constituents, lack of adequate representative data precluded a quantitative assessment. Tables SA-8 and SA-9 of Appendix C identify the types of constituents that were carried forward for detailed analysis and were automatically determined to be assessed qualitatively. For constituents for which at least one data point in the representative data set was a detected value (see Table SA-7, Appendix C), the assessment was either quantitative or qualitative, depending on three factors: (1) adequacy of data to perform a quantitative assessment, (2) adequacy of modeling tools, relative to the physical/chemical properties of the constituent, to perform a quantitative assessment, and availability of these tools, and (3) whether a quantitative analysis was necessary to perform the assessment.

Available tools were considered appropriate for modeling only those constituents that could be assumed to be conservative. Other gain/loss mechanisms were accounted for and addressed qualitatively within the quantitative modeling-based assessment. Constituents of concern that could not be analyzed through quantitative modeling were carried forward for qualitative analysis. Appendix C, Table SA-11 contains a list of water quality constituents for which individual assessments were performed and denotes the constituents that were assessed quantitatively through modeling and those that were assessed qualitatively.

Quantitative Assessments

Using the methodology described below, changes in water quality were determined at 11 assessment locations across the Delta (Figure 8-9) for each of the constituents assessed quantitatively, with the exception of EC. Assessment locations for EC aligned with D1641 compliance locations contained in the Sacramento-San Joaquin Delta WQCP (Bay-Delta WQCP).

Calculation of Changes in Constituent Levels

Output from DSM2 was used to calculate changes in constituent concentrations as they would be affected primarily from operations-related actions of the conveyance features of the Alternatives. DSM2 produced: (1) flow-fraction or "fingerprinting" output; and (2) EC and DOC, concentrations for specified Delta locations. Because the DSM2 model directly simulated EC, and DOC, concentrations throughout the Delta, the estimated daily and monthly average concentrations of these constituents were simply compared among alternatives for impact assessment purposes. Additionally, because DSM2 accounts for hydrodynamic conditions in the Delta, the effects of some of the habitat restoration actions (i.e., CM2 and CM4) on EC and DOC are evaluated quantitatively. Restoration actions that resulted in water quality changes associated with altered hydrodynamics, which were captured in the DSM2 modeling, are discussed in Section 8.3.4 as operations-related water quality changes. Restoration actions that could result in a potential increase in constituent loading (e.g., increased nutrient, organic carbon, or suspended solids) to the Delta region were assessed qualitatively.

For other constituents assessed quantitatively (See Appendix C, Table SA-11) for which concentrations were not directly estimated by DSM2, mean monthly flow-fraction output from DSM2 was used in mass-balance calculations (processed outside of DSM2) to estimate constituent concentrations. The flow-fraction output from DSM2 is the average percentage of water at each specified Delta location that was constituted by the five primary source waters (i.e., SAC, SJR, eastside tributaries, BAY, and AGR). These flow-fractions were used together with source water constituent concentrations derived from historical data to estimate a given constituent concentration at assessment locations according to equation 1:

$$f_{SAC,i}(C_{SAC}) + f_{SJR,i}(C_{SJR}) + f_{EST,i}(C_{EST}) + f_{BAY,i}(C_{BAY}) + f_{AGR,i}(C_{AGR}) = C_i \quad \textbf{(1)}$$

In the above equation, $f_{X,i}$ is the mean monthly flow fraction from source X at assessment location i, C_X is the constituent concentration from source X, and C_i is the constituent concentration at assessment location i.

A key assumption for the mass-balance calculation is that the constituent acts in a conservative manner throughout the system, as the various source waters mix and flow through the Delta, although most behave, to some degree, in a nonconservative manner. For constituents where this assumption does not hold because of decay, uptake, or other losses, this mass-balance approach would be expected to overestimate the actual concentrations at any given Delta location, thereby providing a conservative analysis for impact assessment purposes. Qualitative Assessments

Some constituents were assessed strictly qualitatively (Appendix C, Table SA-11) because: (1) insufficient historical monitoring data were available to adequately characterize the concentrations of the five source waters to the Delta (i.e., to accurately define the distribution of concentrations observed in the SAC, SJR, BAY, eastside tributaries, AGR), which are necessary to implement the quantitative mass-balance assessment approach described above; (2) the locations for which the constituent was assessed (within the affected environment) was outside of any available modeling domain, or available modeling tools were not appropriate for predicting constituent concentrations based on the physical, chemical, and/or biological properties and environmental fate and transport of the constituent. Nevertheless, the same conceptual framework was used for qualitatively assessing constituents of concern. Best available information regarding concentrations/levels in the Delta source waters was evaluated relative to how flow-fractions at various Delta locations would change under the Alternatives, as defined by DSM2 model flow-fraction output (Appendix D), to estimate the relative frequency and magnitude of change expected for a given constituent at a specified location.

Additionally, assessments of the effects of implementing CM2–CM22 were qualitative, at a programmatic level, for all constituents. Construction-related water quality changes also were assessed qualitatively. Potential water quality effects of these generally specific and/or geographically localized actions were assessed by evaluating the anticipated type, duration, and geographic extent of construction activities to take place, and location and type of water bodies potentially affected. The potential for soil, sediment, and contaminants to be discharged to water bodies was determined by identifying construction practices and equipment that could be used, common materials or contaminants that may be present or be used for construction or construction equipment, and pathways by which contaminants may enter receiving waters, and measures to minimize or eliminate adverse construction-related effects on water quality.

8.3.1.4 SWP/CVP Export Service Areas

Assessment of water quality changes in the SWP/CVP Export Service Areas, which begin at the export pumps (i.e., Banks and Jones pumping plants) and extend to facilities receiving exported Delta water, was conducted for construction-related, operations-related, and restoration-related (CM2–CM22) effects.

Water quality changes in the SWP/CVP Export Service Areas were assessed both quantitatively and qualitatively. As described in Section 8.3.2, water quality changes at the export pumps (i.e., Banks and Jones pumping plans) were quantified directly using DSM2 for EC and DOC and from mass-balance calculations based on DSM2 flow-fraction output data and Delta source water quality data, to the extent sufficient source water quality data were available for specific parameters. Water quality changes at the export pumps served as the basis for making determinations of water quality changes within the associated primary conveyance facilities, Delta Mendota Canal and California Aqueduct, as well as the other locations within the service area outside of the Delta, such as San Luis Reservoir and reservoirs operated by southern California water purveyors. Water quality changes in the conveyance and terminus facilities were assessed qualitatively, with consideration of dilution, transformation, uptake, and loss to the extent such factors were applicable to the constituents evaluated.

8.3.1.5 Mercury and Selenium Bioaccumulation Assessment

Mercury and selenium are bioaccumulative constituents of concern in Delta waters. They also are listed as causes of impairment under the Clean Water Act Section 303(d), and a substantial amount is known about their fate and transport within the Delta or similar systems. Consequently, a specific analysis approach was developed for these two constituents.

Mercury and selenium concentrations in surface water were estimated at Delta assessment locations as described previously. Linkages between abiotic media (sediment and surface water, as applicable) and biological tissues (fish muscle, whole-body fish, and bird eggs) that provide an estimate of the potential bioaccumulation and impacts on ecological and human receptors were evaluated to determine the linkages with the greatest degree of confidence. Potential linkages explored included the following.

- **Literature-based regression models or bioaccumulation factors**. These resources provide a basis for estimating tissue concentrations for mercury and selenium from concentrations in surface water or sediment.
- **Site-specific linkages**. Methods were developed to describe existing relationships between waterborne concentrations of mercury and selenium at the nearest modeling nodes, existing sediment (for mercury), and fish tissue concentrations in an attempt to create predictive relationships for impacts analysis and alternatives comparisons.
- **Delta methylmercury**. TMDL (Draft) translation equations for mercury (Central Valley Regional Water Quality Control Board 2008a, 2008b). Translation equations between waterborne concentrations and fish tissue concentrations were investigated.
- **U.S. Geological Survey Bioaccumulation and Trophic Transfer Factors for selenium**. Values for uptake of selenium from water to the lowest trophic levels (e.g., algae) and transfer factors from invertebrates to fish and bird eggs developed by Presser and Luoma (2009) were used to estimate uptake from water to fish and to bird eggs.

Adverse effects on ecological and human receptors were quantified through comparisons of measured and modeled surface water, sediment, and tissue (fish and bird eggs) data to established benchmarks, including the following.

- Water quality objectives and criteria and drinking water standards.
- Literature-derived effect levels in whole-body fish for species most representative of the Delta.
- Literature-derived effect levels in eggs of bird species most representative of the Delta.
- State of California Office of Environmental Health Hazard Assessment's fish contaminant goals and advisory tissue levels.

The alternatives were evaluated with regard to potential adverse impacts on ecological and human receptors through a weight-of-evidence approach. The existing conditions and each alternative were evaluated for their potential to cause exceedances of water quality or tissue benchmarks and for qualitative differences in the spatial extent of those exceedances. The water and tissue concentrations associated with modeled existing conditions were compared to modeled alternatives. In addition, spatial changes in the extent of marshlands associated with each alternative (i.e., CM4–CM10 were evaluated qualitatively for their potential to enhance mercury or selenium bioavailability and risk.

8.3.1.6 Summary of Methods Used to Assess Water Quality Changes Related to Construction, Conveyance and Operations (CM1), and Habitat Restoration and Other Stressor Related Conservation measures (CM2–CM22)

The construction-related water quality changes were assessed qualitatively by evaluating the anticipated type, duration, and geographic extent of construction activities to take place, and location and type of water bodies potentially affected. The potential for soil, sediment, and contaminants to be discharged to water bodies was determined by identifying construction practices and equipment that could be used, common materials or contaminants that may be present or be used for construction or construction equipment, and pathways by which contaminants may enter receiving waters.

Actions associated with new conveyance facilities and operations criteria that resulted in water quality changes associated with altered hydrodynamics, which were captured in the DSM2 modeling, were assessed quantitatively and discussed in Section 8.3.4.

Restoration actions that resulted in water quality changes associated with altered hydrodynamics, which were captured in the DSM2 modeling, are discussed in Section 8.3.4 as operations-related water quality changes (CM1). Restoration actions that could result in a potential increase in constituent loading (e.g., increased nutrient, organic carbon, or suspended solids) to the Delta region were assessed qualitatively.

Each action Alternative addresses other stressors (CM12–CM22) through reducing contaminants and reducing predators and other sources of direct mortality to listed species. Changes in water quality associated with conservation measures implemented to address other stressors were assessed qualitatively under a separate numbered impact for CM2–CM22.

Table 8-39 provides a summary of the methodologies used to assess water quality impacts that could result from implementing the alternatives.

Table 8-39. Summary of Methodologies Used for Water Quality Impact Analyses

Project/ Alternative Component	Available Models/ Techniques	Affected Environment		
		Upstream of the Delta	Plan Area	SWP/CVP Export Service Areas
Conveyance and Operations-related Effects on Water Quality (CM1)	CALSIM II	Hydrologic changes (e.g., seasonal changes in reservoir storage and river flows) used to evaluate dilution effects on constituent levels in reservoirs and rivers.	CALSIM II hydrologic output served as input to the DSM2 model.	Operations of San Luis Reservoir.
	DSM2	N/A	EC, DOC concentrations and flow fractions.	EC, DOCconcentrations directly modeled at the south Delta export pumps
	Reclamation Temperature Model	Direct output to determine changes in temperature at various locations in the Trinity, Sacramento, American, and Stanislaus Rivers.	N/A	N/A
	Mass Balance Using Flow Fraction and Constituent Concentrations	N/A	Estimated concentrations of constituents addressed quantitatively, other than EC, and DOC, which are directly modeled by DSM2.	Estimated concentrations of constituents addressed quantitatively, other than EC, and DOC, at the south Delta export pumps.

Project/ Alternative Component	Available Models/ Techniques	Affected Environment		
		Upstream of the Delta	Plan Area	SWP/CVP Export Service Areas
	Qualitative Analysis	For all parameters other than temperature. Qualitative approach determined whether constituent concentrations were correlated to reservoir storage or river flow levels.	For all parameters not addressed quantitatively (see Appendix C, Table SA-11). Qualitative approach varied based on constituent of concern and location, but attempted to estimate concentration changes attributable to the Alternatives.	For all parameters addressed. Qualitative approach varied based on constituent of concern, but attempted to estimate concentration changes attributable to the Alternatives.
Habitat Restoration-related Effects on Water Quality (CM2–11)	CALSIM II	N/A	CALSIM II hydrologic output served as input to the DSM2 model.	N/A
	DSM2	N/A	To degree possible, the DSM2 model simulated altered Delta hydrodynamics attributable to restoration wetlands.	N/A
	Qualitative Analysis	N/A	Additional qualitative impact analysis of how restoration wetlands may affect specific constituent concentrations (e.g., DOC) in specific areas was provided.	Additional qualitative impact analysis of how restoration wetlands may affect specific constituent concentrations (e.g., DOC) at the south Delta pumps was provided.
Construction-related Effects on Water Quality	Qualitative Analysis	N/A	Qualitative analysis of how short-term conveyance construction activities would affect water quality (e.g., turbidity, sedimentation) was provided.	Qualitative impact analysis of how conveyance construction activities may affect specific constituent concentrations (e.g., turbidity, nutrients) at the south Delta pumps was provided.
Other Stressor-related Effects on Water Quality (CM12–CM22)	Qualitative Analysis	N/A	Qualitative analysis of how actions would affect water quality was provided.	Qualitative impact analysis of how the actions may affect specific constituent concentrations at specified locations was provided.

Notes:
CALSIM II = California Water Resources Simulation Model
CVP = Central Valley Project
DOC = dissolved organic carbon
DSM2 = Delta Simulation Model 2
EC = electrical conductivity
N/A = not applicable
Reclamation = Bureau of Reclamation
SWP = State Water Project

8.3.2 Thresholds of Significance

Both qualitative and quantitative water quality assessments determine the anticipated changes in water quality that may occur throughout the affected environment from implementing an alternative, relative to the water quality conditions that would occur under the Existing Conditions or the No Action Alternative. Changes in water quality determined were then interpreted relative to effects thresholds for the purposes of making impact determinations. The effects thresholds used are as follows.

- Cause exceedance of applicable state or federal numeric or narrative water quality objectives/criteria, or other relevant water quality thresholds identified for this assessment, by frequency, magnitude, and geographic extent that would result in adverse effects on one or more beneficial uses within affected water bodies.
- Increase levels of a bioaccumulative pollutant by frequency, magnitude, and geographic extent such that the affected water body (or portion of a water body) would be expected to have measurably higher body burdens of the bioaccumulative pollutant in aquatic organisms, thereby substantially increasing the health risks to wildlife (including fish) or humans consuming those organisms.
- Cause long-term degradation of water quality, resulting in sufficient use of available assimilative capacity such that occasionally exceeding water quality objectives/criteria would be likely and would result in substantially increased risk for adverse effects on one or more beneficial uses.
- Further degrade water quality by measurable levels, on a long-term basis, for one or more parameters that are already impaired and, thus, included on the state's CWA Section 303(d) list for the water body, such that beneficial use impairment would be made discernibly worse.

The third threshold listed above is triggered not by increased exceedances of water quality standards or adverse impacts on beneficial uses but rather by the more sensitive threshold of demonstrated water quality degradation, on a long-term basis, that eliminates a substantial amount of the receiving water body's available assimilative capacity, thereby resulting in water quality conditions that substantially increase the likelihood of water quality objectives/criteria exceedances and adverse effects on beneficial uses. This threshold would not be exceeded if substantial use of available assimilative capacity is used under the alternative assessed, yet substantial assimilative capacity remains such that exceeding water quality objectives/criteria would be rare, if it were to occur at all and, therefore, resulting water quality poses negligible risk for adverse effects on beneficial uses. Similarly, the fourth threshold above is triggered not by demonstrated or potential adverse effects on beneficial uses, but rather the more sensitive threshold of "measurable degradation," on a long-term basis, under already impaired conditions. This threshold is included in recognition that a threshold of significance should be more sensitive when water quality conditions are already impaired in a water body and, therefore, any measurable worsening, on a long-term basis, may be considered substantial and adverse. This threshold provides meaningful sensitivity for already impaired (i.e., 303(d) listed) conditions by requiring measurable changes, on a long-term basis, rather than "any" change at any time (i.e., a change that could be calculated, but may not be measureable in the actual environment, or may not occur frequently enough to measurably alter water quality on a long-term basis).

8.3.3 Determination of Adverse Effects

The water quality effects of the action alternatives and the No Project Alternative, relative to existing conditions for CEQA, and of the action alternatives relative to the No Action Alternative for NEPA were determined consistent with the Methods for Analysis presented in the previous section, and are presented below. Additional discussion beyond that presented herein pertaining to the potential for water quality-related effects on fish and aquatic resources, human health, and agriculture are addressed in Chapter 11, *Fish and Aquatic Resources*; Chapter 25, *Public Health*; and Chapter 14, *Agriculture*, respectively.

8.3.3.1 Screening Analysis and Results

This water quality analysis assessed the potential effects of implementing the various alternatives on 182 constituents (or classes of constituents). The initial analysis of water quality effects, referred to as the "screening analysis" in the Methods of Analysis section (above) resulted in the following findings. Of the 182 constituents, 110 were determined to have no potential to be adversely affected by the alternatives to an extent to which adverse environmental effects would be expected. Historical data for these constituents showed no exceedances of water quality objectives/criteria in the major Delta source waters, were not on the State's 303(d) list in the affected environment, were not of concern based on professional judgment or scoping comments, and had no potential for substantial long-term water quality degradation. Consequently, no further analyses were performed for these 110 constituents. Conversely, further analysis was determined to be necessary for 72 constituents. Of these, 15 are addressed further in the Screening Analysis itself in Appendix C because they did not warrant alternative-specific analyses, and 1—temperature—is addressed in Chapter 11, *Fish and Aquatic Resources.* [*Note to Lead Agencies: This section in Chapter 11 is in preparation*]. The remaining 56 constituents are addressed in the Environmental Consequences section, and are contained in the sections noted in Table 8-40.

As discussed in the Methods for Analysis section, constituents that require analysis beyond that of the initial screening analysis, and that do not behave conservatively (e.g., degrade or are consumed in biochemical processes) within the system were further assessed qualitatively. Conversely, constituents that are primarily conserved (i.e., do not change) as they move through the system (e.g., dissolved salts) were candidates for further quantitative assessments, via comparisons of modeled scenarios that depict the existing conditions, No Action Alternative, and the action alternatives (Table 8-40).

8.3.3.2 Comparisons

For hydrologic (i.e., CALSIM) modeling purposes, which depicts CVP and SWP system-wide operations and thus how water would be routed through the Delta, existing conditions, the No Action Alternative NT and LLT, and the action alternatives LLT were partly defined according to the key inputs shown in Table 8-41. For the quantitative and qualitative assessments performed, comparisons of the assessment scenarios were made consistent with Table 8-42 and are presented in the Effects and Mitigation Approaches section, below.

Table 8-40. Water Quality Constituents for which Detailed Assessments are Performed

Constituents Carried Forward for Further Analysis	Quantitative	Qualitative	Section of Environmental Consequences
Ammonia		X	Ammonia
Boron	X		Boron
Bromide	X		Bromide
Chloride	X		Chloride
Oxygen		X	Dissolved Oxygen
Conductance (EC)	X		Electrical Conductivity (EC)/TDS
Total Dissolved Solids	X		Electrical Conductivity (EC)/TDS
Mercury	X		Mercury
Nitrate	X	X	Nitrate
Nitrite		X	Nitrate
Nitrite + Nitrate		X	Nitrate
Organic Carbon	X		Organic Carbon (DOC/TOC)
Haloacetic acids [a]		X	Organic Carbon (DOC/TOC)
Trihalomethanes [b]		X	Organic Carbon (DOC/TOC)
Cryptosporidium		X	Pathogens
Escherichia™coli		X	Pathogens
Organochlorine, Organophosphate, and Pyrethroid Pesticides [c]		X	Pesticides and Herbicides
Phosphorus		X	Phosphorus
Selenium	X		Selenium
Other Trace Metals [d]		X	Trace Metals
Total Suspended Solids		X	Turbidity and TSS
Volatile Suspended Solids		X	Turbidity and TSS
Turbidity		X	Turbidity and TSS

[a] Dibromoacetic Acid (DBAA), dichloroacetic Acid (DCAA), trichloroacetic Acid (TCAA), total haloacetic acids

[b] Bromodichloromethane, bromoform, dibromochloromethane, total THMs

[c] Aldrin, BHC, BHC-alpha, BHC-beta, BHC-delta, BHC-gamma (lindane), chlordane, chlorpyrifos, diazinon, dieldrin, endosulfan (mixed isomers), endosulfan-I, endosulfan-II, endrin, heptachlor, p,p'-DDD, p,p'-DDE, p,p'-DDT, toxaphene, pyrethroids

[d] Arsenic, cadmium, copper, lead, manganese, nickel, zinc, aluminum, silver

Table 8-41. Water Quality Assessment Scenarios

Input Parameters	Existing Conditions	No Action Alternative – NT	No Action Alternative – ELT	No Action Alternative – LLT	Alternatives – LLT
Surface Water Demands [a]	2005 / Recent Historical	2025 / Full Water Rights	2025 / Full Water Rights	2025 / Full Water Rights	2025 / Full Water Rights
Conveyance	Through Delta	Through Delta	Through Delta	Through Delta	Various
CVP/SWP Operational Criteria	Per USFWS and NMFS BioOps RPAs [b]	Per USFWS and NMFS BioOps RPAs [b]	Per USFWS and NMFS BioOps RPAs [b]	Per USFWS and NMFS BioOps RPAs [b]	Various
Fall X2	No	Yes	Yes	Yes	Some Yes, Some No
Climate Change / Sea Level Rise	None	None	Year 2025	Year 2060	Year 2060

Notes:

NT = Near-term.

ELT = Early long-term

LLT = Late long-term.

[a] This is a simplified characterization of the water demands to illustrate the differences between the scenarios. Water demands for some purveyors under the No Action and action alternatives are the same as those under Existing Conditions, while others are increased to a full contract amount or 2030 level. See CALSIM II modeling assumptions for specific differences.

[b] USFWS/NMFS Biological Opinions (BioOps) RPAs is described in Appendix X.

Table 8-42. Scenario Comparisons Performed for Impact Assessment Purposes

Comparison		Purpose of Comparison
1	Existing Conditions versus Alternatives LLT (including No Action Alternative LLT)	A required comparison to current conditions for CEQA purposes. Shows effects due not only to changes in conveyance and operational criteria defined by the alternative (CM 1), including meeting fall X2, but also the effects of future surface water demands and climate change/sea level rise.
2	No Action Alternative NT versus Alternatives LLT (including No Action Alternative LLT)	Identifies potential alternative-specific effects caused by changes in conveyance and operating criteria (CM1), as well as climate change/sea level rise. Difference in effects for this comparison compared to that shown in comparison of alternatives to Existing Conditions (i.e., #1 above) shows the effects due to fall X2 and future water demands.
3	No Action Alternative LLT versus Alternatives LLT	Identifies potential alternative-specific effects caused by changes in conveyance and operating criteria (CM1). Difference in effects for this comparison compared to that shown in comparison of alternatives to No Project NT (i.e., # 2 above) shows the effects due to climate change/sea level rise occurring in 2060.

8.3.3.3 Effects Assessment Considerations

Both qualitative and quantitative water quality assessments determine the anticipated changes in water quality that may occur throughout the affected environment from implementing an alternative, relative to the water quality conditions that would occur under the existing conditions or the No Action Alternative NT and LLT. Changes in water quality determined were then interpreted relative to key effects assessment considerations for the purposes of determining whether adverse water quality related effects would occur. The key effects assessment considerations used are as follows.

1. Cause exceedance of applicable state or federal numeric or narrative water quality objectives/criteria, or other relevant water quality effects thresholds identified for this assessment, by frequency, magnitude, and geographic extent that would result in adverse effects to one or more beneficial uses within affected water bodies.
2. Increase levels of a bioaccumulative pollutant by frequency, magnitude, and geographic extent such that the affected water body (or portion of a water body) would be expected to have measurably higher body burdens of the bioaccumulative pollutant in aquatic organisms, thereby substantially increasing the health risks to wildlife (including fish) or humans consuming those organisms.
3. Cause long-term degradation of water quality in one or more water body of the affected environment, resulting in sufficient use of available assimilative capacity such that occasionally exceeding water quality objectives/criteria would be likely and would result in substantially increased risk for adverse effects to one or more beneficial uses.
4. Further degrade water quality by measurable levels, on a long-term basis, for one or more parameters that are already impaired and, thus, included on the State's Clean Water Act Section 303(d) list for the water body, such that beneficial use impairment would be made discernibly worse.

The third effect assessment consideration listed above is triggered not by increased exceedances of water quality standards or adverse impacts on beneficial uses, but rather by the more sensitive threshold of demonstrated water quality degradation, on a long-term basis, that eliminates a substantial amount of the receiving water body's available assimilative capacity, thereby resulting in water quality conditions that substantially increase the likelihood of water quality objectives/criteria exceedances and adverse effects to beneficial uses. This assessment consideration would not be met if a substantial amount of available assimilative capacity is used under the alternative assessed, yet substantial assimilative capacity remains such that exceeding water quality objectives/criteria would be rare, if it were to occur at all and, therefore, resulting water quality poses negligible risk for adverse effects to beneficial uses. Similarly, the fourth effect assessment consideration above is met not by demonstrated or potential adverse effects to beneficial uses, but rather the more sensitive threshold of "measurable degradation," on a long-term basis, under already impaired conditions. This effect assessment consideration is included in recognition that an adverse effects determination should be more sensitive when water quality conditions are already impaired in a water body and, therefore, any measurable worsening, on a long-term basis, may be considered substantial and adverse. This assessment consideration provides meaningful sensitivity for already impaired conditions by requiring measurable changes, on a long-term basis, rather than "any" change at any time (i.e., a change that could be calculated, but may not be measureable in the actual environment, or may not occur frequently enough to measurably alter water quality on a long-term basis).

8.3.3.4 Constituent-Specific Considerations Used in the Assessment

Construction-Related Water Quality Effects

Water quality effects associated with temporary and intermittent construction activities were assessed in a qualitative manner. The potential construction-related water quality effects were assessed considering many aspects of the work involved and potential environmental exposure to contaminants, including, but not limited to the following factors:

- Types of materials and contaminants that may be handled, stored, used, or produced at project facilities during project construction, and which could be released to the environment, and the related fate, transport, and harmful characteristics of the contaminants.
- Magnitude, timing, and duration of the potential contaminant discharges, and exposure sensitivity of water bodies and beneficial uses that could be affected by the discharge.
- Routes of exposure for contaminants from the activity causing potential discharges to sensitive water bodies, including likelihood of seasonal exposure to rainfall and runoff, proximity of inland work to drainage ways, occurrence of direct instream discharges, and whether exposure would involve long-term effects of tidal flow in the estuary.

The assessment of potential water quality effects considered all of the beneficial uses. However, given the generally temporary and intermittent characteristics of construction and maintenance discharges, a focus of the assessment is on effects to aquatic life as the likely most sensitive beneficial uses in the receiving water (also refer to Chapter 11, *Fish and Aquatic Resources*, for additional discussion of the effects of construction). In particular, large or sudden increases in contaminant concentrations from construction or operations/maintenance activities are most likely to affect short-term, sensitive water quality characteristics such as acute health responses of aquatic organisms and their habitats. Other beneficial uses, such as municipal/industrial water supplies, recreational activities, or livestock/agricultural irrigation, are generally anticipated to be less sensitive to short-term water quality disturbances.

Ammonia

Ammonia-N is present in some types of agricultural runoff (i.e., fertilizers, animal wastes), fish and other wildlife wastes, and atmospheric depositions (Ballard *et al.* 2009). The Sacramento Regional Wastewater Treatment Plant (SRWTP) discharge into the Sacramento River at Freeport is the largest single point source of ammonia-N in the Delta.

In the aquatic environment ammonia-N may rapidly cycle between the water, organisms, and sediments. The presence of high concentrations of ammonia-N is usually associated with reducing conditions and/or locally high concentrations of ammonia-N discharge such as near WWTP discharges. Ammonia-N is rapidly oxidized in the flowing river environment to nitrate-N. More than three quarters of the ammonia present in the Sacramento River downstream of Freeport is converted to nitrate by the time the water reaches Chipps Island (Foe Central Valley Regional Water Quality Control Board 2010 Update memo:4).

Concerns regarding ammonia in the Delta include potential toxicity to fish and other organisms, shifts in algal community structure (i.e., dominant species), and inhibition of nitrate uptake by diatoms. Nutrient concentrations currently in the Delta are high enough that they are probably not a true limiting factor for algal growth. However, it is unclear if nutrient levels are adversely affecting primary productivity. For example, recent work has suggested that elevated blue-green algal concentrations in the Delta interior were associated with nitrogen (including ammonia) and phosphorus concentrations (Lehman et al. 2010). In addition, Glibert (2010) analyzed over 30 years of Delta water quality data, concluding that aquatic organism population shifts were associated with changes in the quality and quantity of nutrients discharged from the SRWTP. Subsequently, others have refuted this work by demonstrating that the statistical techniques used were not appropriate and, therefore, that the conclusions were flawed (Cloern et al. 2011:1). Research has also indicated that ammonia, while stimulating diatom growth at very low concentrations, can also inhibit uptake of nitrate in diatoms as concentrations increase above about 4 µmol/L (0.056 mg/L-N; Dugdale et al 2007:23). This may be of concern in Suisun Bay, where algal blooms may be prevented when conditions would otherwise be favorable (Wilkerson et al 2006:1).

Research assessing the effects of N and P on phytoplankton in the Delta is far from complete due in part to the large number of physical, chemical, and biological interactions occurring in the Delta. In addition to nutrients, Delta phytoplankton can be impacted by light conditions, filtration feeders (e.g., *Corbula amuransis*, *Cobicula fluminea*), and microbial processing of organic carbon, to name a few factors (SRCSD 2009). Manipulation of all these factors to determine their relative contribution to Delta phytoplankton quantity/quality is a significant task that will likely require a broad array of experiments (both laboratory and field) to tease apart causal relationships.

The beneficial uses that could be affected most by ammonia concentrations include aquatic organisms (cold freshwater habitat, warm freshwater habitat, and estuarine habitat), or activities that depend on aquatic life (shellfish harvesting, commercial and sport fishing). Drinking water supplies (municipal and domestic supply) and recreational activities (water contact recreation, noncontact water recreation) are indirectly affected from nuisance eutrophication effects of ammonia.

There are no Clean Water Act section 303(d) listings for ammonia in the affected environment. The Region 2 Basin Plan objective for ammonia-N is 25 mg N/L as a 4-day average. The U.S. EPA has established criteria for ammonia-N with respect to the toxicity of un-ionized ammonia-N, which is dependent upon water temperature and pH (U.S. EPA 1999; 2009). The 2009 document represents draft criteria, so for the purposes of this analysis, both the 1999 recommendations and the 2009 draft criteria were used. U.S. EPA's 2009 draft recommended criteria are more restrictive than its 1999 recommended criteria. Values derived for water at 25 °C and pH 8 are shown in Table 8-43, and were used as the reasonable worst case (i.e., most sensitive) criteria in the affected environment. The chronic criteria derived according to the 2009 draft documentation (0.26 mg/L-N) is also lower than the LOEL of 0.36 mg/L-N for chronic effects recently derived to *P. forbesi*, a copepod within the affected environment (Teh et al. 2011:2).

A final relevant threshold includes a recommended goal for sensitive crops of 1.5 mg/L-N (Ayers and Westcot 1985). It is assumed that ammonia is beneficial for crops at levels below this threshold, and thus that any increases in ammonia-N concentrations that are below the 1.5 mg/L-N threshold are generally not of concern for agriculture.

Table 8-43. Applicable Federal Criteria, State Objectives, and Other Relevant Effects Thresholds for Ammonia (mg N/L)

	Region 5 Basin Plan	Region 2 Basin Plan[a]	CTR	Drinking Water MCL	U.S. EPA Recommended Criteria	Other Relevant Thresholds
Ammonia-N	--	25	--	--	5.6/1.2 (1999)[b] 2.9/0.26 (2009)[c]	1.5[d], 0.36[e]

[a] San Francisco Bay Regional Water Quality Control Baord 2007. 25 mg/L 4-day average for ammonia-N.
[b] First value represents acute, salmon present, second value represents chronic, fish early life stage s present, for water temperature 25 °C and pH 8.
[c] First value represents acute, freshwater mussels present, second value represents chronic, freshwater mussels present, for water temperature 25 °C and pH 8.
[d] Ayers and Westcot (1985). Recommended goals for sensitive crops
[e] Lowest Observed Effect Level (LOEL) determined in Teh et al. 2011, for chronic effects on *P. forbesi.*

Figure 8-59 shows the seasonal levels of ammonia in the three major source waters to the Delta—the Sacramento River (SAC), the San Joaquin River (SJR), and San Francisco Bay (BAY). The data indicate that SJR and BAY concentrations are similar during all months of the year. SAC concentrations are greater than BAY or SJR virtually all of the time, being more similar in January through March and much greater during the rest of the year. The high concentrations of ammonia in SAC are a result of the SRWTP, which discharges into the Sacramento River at Freeport. Ammonia concentrations upstream of the SRWTP are similar to those in BAY and SJR (Foe Central Valley Regional Water Quality Control Board 2010, p.5).

The SRWTP NPDES permit was renewed by the Central Valley Regional Water Quality Control Board on December 20, 2010. The permit contains effluent limitations for ammonia-N of 1.8 mg/L on an average monthly basis, and 2.2 mg/L on a maximum daily basis (Central Valley Regional Water Quality Control Board 2010:14) that must be achieved by December of 2020 (p. 34). In order to meet these limits, the SRWTP must be upgraded to include nitrification. For the purposes of this assessment, assumptions were made regarding the status of the upgrades under the various baselines, alternatives, and time-steps, and these are summarized in Table 8-44.

Table 8-44. Assumptions on Status of Sacramento Regional Wastewater Treatment Plant Nitrification Upgrades Under Assessment Scenarios

Scenario	Status of Upgrades	Average Monthly Effluent Limit, mg/L as N
Existing Conditions	No Upgrades	33
No Action Alternative, Near Term	No Upgrades	33
No Action Alternative, Late Long Term (2060)	Upgrades Complete	1.8
Alternatives 1-9, Late Long Term (2060)	Upgrades Complete	1.8

Boron

Boron is a chemical element naturally occurring in the Earth's crust. Natural boron is commonly found in industrially useful minerals, perhaps most notably borax— a salt of boron that has found utility in detergents, fire retardants, swimming pool buffering agents, and the production of fiberglass and other common uses. Natural weathering of rocks is believed to be the primary source of boron in water (ATSDR 2007).

Sensitive receptors that have the potential to be affected by elevated concentrations of boron are municipal and industrial water supply beneficial uses (Municipal and Domestic Supply/Industrial Service Supply) and agricultural supply beneficial uses. Agricultural supply uses, specifically crop irrigation, are the most sensitive receptor to boron due to issues related to boron deficiency (Nable et al. 1997) and boron toxicity (Chauhan and Power 1978, Nable et al. 1997) in crops. Ayers and Westcott (1994) provide a discussion of boron toxicity to plants. Very sensitive plants, which include lemons and blackberries, may show signs of toxicity at concentrations less than 500 µg/L, but are not widely grown in the Delta and areas upstream (refer to Chapter 14, *Agricultural Resources*). Sensitive crops begin to show signs of toxicity between 500 and 750 µg/L, and include a variety of fruit and nut trees which are commonly grown in the Delta.

Applicable boron objectives for the affected environment are summarized in (Table 8-45). Because boron is not a priority pollutant, there are no criteria established for boron in the National Toxics Rule or CTR. The Bay-Delta WQCP also does not contain objectives for boron. As an outcome of the Section 303(d) listing for the lower San Joaquin River and associated TMDL development process, the Central Valley Basin Plan contains a monthly average boron objective for the lower San Joaquin River to Vernalis of 800 µg/L for the irrigation season (i.e., March 15 through September 15), and 1,000 µg/L for the non-irrigation season (CVRWQCB 2009a). Additionally, the San Francisco Bay Basin Plan contains agricultural objectives, with a lower value of 500 µg/L for irrigation, and a value of 5,000 µg/L for drinking water.

Table 8-45. Applicable Federal Criteria, State Objectives, and other Relevant Effects Thresholds for Boron

	Region 5 Basin Plan[a]	Region 2 Basin Plan	USEPA Recommended Criteria
Boron (µg/L)	800 / 2000 [b] 1,000 / 2,600 [c] 1300 [d]	500 / 2,000 [e] 5,000 [f]	2,000 / 5,000 [g]

Notes:

[a] Basin Plan objectives apply to the lower San Joaquin River from the mouth of the Merced River to Vernalis (CVRWQCB 2009a).

[b] Agricultural objective for March 15 through September 15 specified as (monthly average) / (maximum) concentration.

[c] Agricultural objective for September 16 through March 14 specified as (monthly average) / (maximum) concentration.

[d] Agricultural objective applicable year-round as a monthly average for critical water years.

[e] Basin Plan agricultural objectives specified for irrigation as (threshold concentration) / (limit concentration) (SFBRWQCB 2007).

[f] Basin Plan agricultural objective specified for stock watering (SFBRWQCB 2007).

[g] Recommended human health advisory levels for long-term exposure through drinking water supplies specified in the form of (children)/(adults) (USEPA 2008f).

Sources of boron to Delta waters include the Sacramento River, the San Joaquin River, the Eastside tributaries, Delta agricultural return drains, and the San Francisco Bay. Among these sources, San Francisco Bay water contains the highest boron concentrations, followed by Delta agricultural returns, the San Joaquin River, the Sacramento River,and the Eastside tributaries (Table 8-46). Point source discharges containing boron contribute a small fraction of the boron burden to the lower San Joaquin River (CVRWQCB 2009a).

The lower San Joaquin River is listed on the State's Clean Water Act (CWA) section 303(d) list of impaired water bodies for salt and boron (SWRCB 2011). Boron is paired with salt in this listing due to its regular association with saline waters. The Central Valley Regional Water Board has prepared a TMDL with implementation program where it is assumed that actions taken to control salts also will control for boron as well (CVRWQCB 2006).

Because of boron's elemental nature, it is considered a conservative constituent, not subject to degradation through volatilization, breakdown, or uptake as it moves through the system. Boron, however, does adsorb to mineral soils and organic matter, which allows for its accumulation in soils irrigated with water containing boron. Because of its ability to leach through soils, this partitioning can be considered temporary; therefore, the assessment of potential impacts from boron assumes that mass is generally conserved. Consequently, boron concentrations at any location in the Delta primarily reflect the mass balance of the flow and concentrations of the major water sources. Therefore, a quantitative mass-balance approach using the source water flow fractions from the DSM2 model output and source water concentrations was used to estimate boron concentration changes that would occur with the alternatives. The long-term average source water concentrations were used for most locations in the mass-balance assessment; however, due to the presence of a distinct seasonal pattern in the boron concentrations of the San Francisco Bay source water at the interface with the Delta in relation to seasonal Delta outflow pattern, monthly average concentrations were used for this location. Additionally, sample data for boron at the Martinez location were limited to literature values for the annual average concentration, whereas substantial monthly data were available for the Sacramento River at Mallard Island. Consequently, monthly average Martinez concentrations were estimated by simple linear extrapolation of the monthly average Mallard Island concentrations by the ratio of the annual average Mallard Island to Martinez concentration.

1 **Table 8-46. Historical Boron Concentrations in the Five Delta Source Waters**

	Source Water				
Data parameters	Sacramento River	San Joaquin River	San Francisco Bay[a]	East Side Tributaries	Delta Agriculture Return Waters[b]
Mean (µg/L)	100	349	880	68	492
Minimum (µg/L)	100	100	-	10	103
Maximum (µg/L)	200	1,100	-	250	1192
75th Percentile (µg/L)	100	400	-	100	584
99th Percentile (µg/L)	100	918	-	244	1159
Data source	DWR	DWR	Paulsen and List (1997) and DWR	USGS	DWR
Station(s)	Sacramento River at Greene's Landing, Sac River at Hood	San Joaquin River at Vernalis	Martinez and Sacramento River at Mallard Island	Cosumnes River	-- [b]
Date range	1986–2009	1986–2009	1986–2009	1953–1977	1987–2001
ND replaced with RL[c]	Yes	No	No	Yes	Yes
Data omitted	Two data points assumed to be in error (1,900 µg/L, 1,000 µg/L)	None	None	None	None
No. of Data Points	468	483	265	60	339

[a] No data available for boron at Martinez in any of the available data sets. Paulsen and List (1997) measured boron daily at Martinez from 4/13/96 – 8/29/96. Paulsen and List (1997) lists only the mean, minimum, and maximum concentrations found. However, extensive boron data was available for the Sacramento River at Mallard Island (i.e., DWR MWQI program data for 1986-2009) which indicated a strong seasonal concentration pattern in the western Delta. Consequently, to estimate the seasonal monthly average boron concentrations at Martinez, the monthly average mean values for Mallard Island were multiplied by the ratio of the average Martinez (Paulsen and List 1997) to long term average Mallard Island mean concentrations. Refer to Appendix 8F, Table Bo-1 for additional information and tabulation of the calculated monthly average boron concentrations for the Bay source water.

[b]Agricultural return drains are distributed unevenly throughout the Delta. Water quality associated with these drains varies depending on the specific location of the drain within the Delta, and largely coincides with the water quality of the water that is withdrawn from the Delta for application onto agricultural lands. In order to characterize boron concentrations in agricultural drain water as a whole, the following process was followed:

- All boron data from those agricultural drains from the DWR Water Data Library, which had historical boron data, were placed into a database.
- The drains were assigned a region in the Delta according to their location (Central, North, East, South, and West)
- Three drains from each region were chosen at random, and the data from each of these drains was downloaded.
- The stations selected included: Ag Drain on Jersey Island, Ag Drain on King Island, PP. No. 1, Ag Drain on King Island, PP. No. 2, Ag Drain on Orwood Tract, Ag Drain on Palm Tract, Ag Drain on Pescadero Tr., PP. No. 3, Ag Drain on Pescadero Tract, PP. No. 4, Ag Drain on Rindge Tract, PP. No. 1, Ag Drain on Twitchell Isl., PP. No. 1, Ag Drain on Pescadero Tr., PP. No. 1
- To derive an overall mean, minimum, maximum, 75th, and 95th percentile, the mean, minimum, maximum, 75th and 95th percentiles of the individual drain averages was calculated.

The process was an attempt to derive values that were representative of the Delta as a whole, regardless of how many drains in each region had data, and how many data points existed at each drain.

[c] In some cases, data were reported as non-detects, and the entry contained an accompanying reporting limit. "Yes" indicates that at least one non-detect was replaced with the reporting limit in order to calculate summary statistics, while "No" indicates that this was not done, generally because no data were reported as non-detect.

2

The mass-balance modeling results were used to compare predicted changes in assessment variables (e.g., exceedances of objectives/criteria, amount of water quality degradation relative to boron, and contribution to 303(d) impairment effects). The assessment of effects relative to applicable objectives/criteria for the protection of agricultural beneficial uses was based on changes in monthly average concentrations modeled for all water year types for the 16-year (1976–1991) hydrologic period of record and for the drought years only (i.e., 1987–1991), and the effects relative to municipal and industrial water supply was based on changes in annual average concentrations for the modeled 16-year and drought periods.

The implementation of conservation measure CM4 would restore substantial areas of tidal habitat that would increase the magnitude of daily tidal water exchange at the restoration areas, and could alter other hydrodynamic conditions in adjacent Delta channels. San Francisco Bay water is a substantial source of boron, thus, the increased tidal exchange resulting from tidal habitat restoration may increase boron concentrations in the portion of the Bay water that enters the western Delta. The DSM2 modeling included assumptions regarding possible locations of tidal habitat restoration areas, and how restoration would affect Delta hydrodynamic conditions and source water flow fractions. However, the magnitude of increased boron concentrations in Bay source water in the western Delta as a result of increased tidal exchange is uncertain. Consequently, the potential effects of tidal restoration on boron concentrations in the Bay source water was assessed qualitatively based on predicted changes in the Bay source water fraction. The effects of other conservation measures (i.e., CM2, CM3, and CM5–CM22) which do not substantially affect flows or Delta hydrodynamic conditions, also were assessed qualitatively.

Bromide

Bromide is an inorganic anion that is generally present at low concentrations in freshwater bodies, but averages about 65 mg/L in seawater (Morris and Riley 1966: 699). Tidal seawater intrusion is the primary source of bromide in the Delta. Bromide concentrations also can be generally higher in the lower San Joaquin River and Delta island agricultural drainage as a result of recirculation and evaporative concentration which occurs in water diverted from the Delta for irrigated agriculture. As an inorganic anion, bromide is generally conservative in the aquatic environment and its fate and transport characteristics are similar to other salinity constituents. Bromide is a human health concern for drinking water supplies taken from the Delta because it is a precursor for disinfection byproduct (DBP) formation in water treatment plants, such as bromate and brominated trihalomethane compounds.

Consequently, bromide concentrations at a particular location and time in the Delta are determined primarily by the sources of water to that location, at a given time. Hence, long-term average concentrations at a particular Delta location are determined primarily by the long-term average sources of water to that location, and the long-term average concentration of bromide in each of the major source waters to the location. The major source waters to any given Delta location are: (1) Sacramento River, (2) San Joaquin River, (3) Bay water, (4) eastside tributaries, and (5) agricultural return water.

Bromide is not a priority pollutant, thus, the CTR has no criteria for bromide. There are no state or federal regulatory water quality objectives/criteria for bromide, nor any U.S. EPA-recommended criteria. As a consequence, none of the water bodies in the affected environment have been listed as impaired on the state's Clean Water Act section 303(d) list due to elevated bromide. However, the

CALFED Drinking Water Program established a goal for bromide of 50 µg/L as a long-term average as applied to municipal drinking water intakes drawing water from the Delta (CALFED 2000). Specifically, the goal of the CALFED Drinking Water Program is to:

> "achieve either: (a) average concentrations at Clifton Court Forebay and other southern and central Delta drinking water intakes of 50 µg/L bromide and 3.0 mg/L total organic carbon, or (b) an equivalent level of public health protection using a cost-effective combination of alternative source waters, source control, and treatment technologies."

Bromide is not routinely monitored in surface water samples collected north of the Delta, primarily due to the low concentration of bromide in this region. Data available for the American River suggests that bromide concentrations are <10 µg/L. Table 8-47 provides a summary of bromide concentrations in the primary source waters of the Delta, as well as information on the source of the data and summary statistics. Due to the quality and quantity of data available, as well as the conservative nature of the constituent, a quantitative assessment utilizing a mass-balance approach was employed in the assessment of alternatives. Because bromide is a precursor to the formation of DBPs which represent a long-term risk to human health, and because the existing source water quality goal is based on a running annual average, the quantitative assessment focuses on the degree to which an alternative may result in change in long-term average bromide concentrations at various locations throughout the affected environment. For municipal intakes located in the Delta interior, assessment locations at Contra Costa Pumping Plant No.1 and Rock Slough are taken as representative of Contra Costa's intakes at Rock Slough, Old River and Victoria Canal, and the assessment location at Barkley Cove is taken as representative of the City of Stockton's intake on the San Joaquin River. Municipal intakes at Mallard Slough, City of Antioch, and the North Bay Aqueduct are represented by their respective assessment locations. For the purposes of this assessment, bromide concentrations for water transported into the SWP/CVP Export Service Areas are assessed based on concentrations at the primary SWP and CVP Delta export locations (i.e., Banks and Jones pumping plants).

Table 8-47. Source Water Concentrations for Dissolved Bromide (µg/L)

Source Water	Sacramento River	San Joaquin River	San Francisco Bay[a]	Eastside Tributaries	Agriculture in the Delta
Mean (µg/L)	15	251	13,149–32,951	16	456
Minimum (µg/L)	1	20	28–17,465	14	20
Maximum (µg/L)	100	650	33,985–44,100	17	2,720
75th Percentile (µg/L)	20	345	22,313–38,500	N/A	580
99th Percentile (µg/L)	44	565	22,313–38,500	N/A	1,850
Data Source	DWR	DWR	BDAT	BDAT	DWR
Station(s)	Sac River at Greene's Landing, Sac River at Hood	SJR at Vernalis	[b]	Mokelumne River at Sacto Road	[c]
Date Range	1990–2009	1990–2009	1980–2007	1990–1990	1990–2001

Source Water	Sacramento River	San Joaquin River	San Francisco Bay[a]	Eastside Tributaries	Agriculture in the Delta
ND Replaced with RL	Yes	No	No	No	No
Data Omitted	None	None	None	None	Yes [d]
No. of Data Points	560	547	26–27	2	991

[a] Values reported as range of monthly values (minimum monthly–maximum monthly). Trends in monthly average bromide at Martinez suggested a seasonality to concentration. Due to the appearance of seasonality in monthly average concentration at this location, average monthly concentration was used. Actual monthly values for the dataset are provided in Appendix 8E, Bromide Table 1.

[b] Measured bromide data at Martinez was not available for this analysis. Bromide data at Martinez was estimated from the regressed relationship of bromide to chloride at Mallard Island (Appendix 8E, Bromide Figure 1). The empirical relationship of bromide to chloride obtained at Mallard Island was similar to that of ocean water (Morris and Riley 1966), or 0.0035 parts bromide to 1 part chloride. Bromide data at Martinez used in this analysis therefore represents measured Martinez chloride multiplied by a factor of 0.0035.

[c] Values calculated from all agriculture drain data pooled together. All bromide data from agricultural drains contained in the DWR Water Data Library were placed into a single database. Due to the uneven distribution of agricultural drains in the Delta, geographical trends in agricultural drain water quality were evaluated by categorizing the data based on their associated location in the Delta. Categories included western, southern, northern, eastern, and central Delta, following the geographical delineations of the State Water Resources Control Board. With data pooled and categorized by region, average concentration by region were compared. Average bromide varied by less than a factor of 3, with highest concentration in the southern Delta and lowest in the central Delta. No bromide data was available for the northern Delta. Due to the apparent low regional variability, values were obtained by pooling all data together and obtaining summary statistics from this pooled database.

[d] Data for the Byron Tract #2 and Byron Tract #3 agricultural drains were omitted from the database due to their reported values being substantially outside the distribution of all other values. These values were: 65,000 µg/L and 46,800 µg/L. In total, 2 data points were omitted and 991 were retained.

As demonstrated in Table 8-47, achieving the CALFED goal of 50 µg/L bromide at drinking water intakes is severely challenged by the quality of at least three of the five primary source waters, where long-term average concentrations exceed this goal many fold in the source waters themselves. In establishing its source water goal for bromide, CALFED assumed more stringent DBP criteria for treated drinking water than are currently in place. Source water with bromide between 100 µg/L and 300 µg/L is believed sufficient to meet currently established drinking water criteria for DPBs, depending on the amount of *Giardia* inactivation required (CUWA 1998, ES2). This assessment of alternatives evaluates how each alternative would affect the frequency with which predicted future bromide concentrations would exceed 50 µg/L and 100 µg/L on a long-term average basis at the assessment locations. Because, in many cases, the existing condition is one already exceeding 50 µg/L, the frequency with which bromide exceeds 100 µg/L becomes a key focus of the assessment, as well the change in long-term average bromide concentration.

Chloride

Chloride is an inorganic anion generally found at low concentrations in freshwater bodies; however, chloride is the dominant anion in seawater at about 19,000 mg/L (Hem 1985). Chloride commonly occurs in nature as salts of sodium, potassium, and calcium. Tidal seawater intrusion is the primary source of chloride in the Delta. Delta tidal water containing elevated levels of chloride, which is subsequently diverted for agricultural irrigation uses onDelta islands or exported from the Delta via the Jones pumping plant to the San Joaquin valley, returns to the Delta as agricultural drainage (CALFED Bay-Delta Program 2007). Chloride concentrations in these return flows to the Delta can contain additional chloride as a result of evaporative concentration of salts which occurs in water diverted for agricultural irrigation. Chloride is a potential concern for crop yields in agricultural irrigation water, and excess chloride can impart an unpalatable, "salty" taste in drinking water supplies. Taste thresholds for chloride range from 200–300 mg/L, depending on the associated cation (WHO 1993).

Applicable chloride objectives for the affected environment are summarized in (Table 8-48). Chloride is not a priority pollutant and has no criteria under the National Toxics Rule and CTR. The Bay-Delta WQCP contains chloride objectives for municipal and industrial water supply beneficial uses protection including a maximum mean daily concentration of 250 mg/L year-round at the five major municipal water supply diversion locations – Contra Costa Canal at Pumping Plant #1, West Canal at Mouth of Clifton Court Forebay, Jones pumping plant, Barker Slough at North Bay Aqueduct, and Cache Slough at the City of Vallejo Intake (which is currently abandoned). Additionally, the Bay Delta WQCP contains a chloride objective for Contra Costa Canal at Pumping Plant #1 or the San Joaquin River at Antioch Water Works Intake which specifies the number of days each calendar year that the maximum mean daily chloride concentration must be less than 150 mg/L (must be provided in intervals of not less than two weeks duration). The days per year depend on water year type ranging from 155 days for critical water year types to 240 days in wet water year types. The industrial uses for which this objective was established (i.e., cardboard manufacturing in Antioch) no longer exist; however, the objective has been retained for general municipal use protection (CALFED Bay-Delta Program 2007a). The secondary MCL for chloride, like the EC, TDS, and sulfate MCLs, is specified as a range: 250 mg/L (recommended), 500 mg/L (upper), and 600 mg/L (short-term), and is applicable to all surface waters in the affected environment, other than the Delta, that have the municipal and domestic supply beneficial use designation. The U.S. EPA's recommended chloride ambient water quality criteria for the protection of freshwater aquatic life are 230 mg/L (chronic 4-day average) and 860 mg/L (acute 1-hour average).

One channel in the southern Delta (Tom Payne Slough) and the Suisun Marsh wetlands are on the state's CWA Section 303(d) list due to elevated chloride (State Water Resources Control Bard2011). Additionally, the lower San Joaquin River is on the 303(d) list as impaired for salt and boron and a TMDL has been developed, with chloride identified as comprising about 23% of the total ions contributing to salinity in the lower San Joaquin River at the Vernalis location in the Delta (Central Valley Regional Water Quality Control Board 2002).

As an inorganic anion, chloride is generally conservative in the aquatic environment and its fate and transport characteristics are similar to other salinity constituents. Consequently, chloride concentrations at any location in the Delta primarily reflect the mass balance of the flow and concentrations of the major water sources. Therefore, a quantitative mass-balance approach using the source water flow fractions from the DSM2 model output and source water concentrations was used to estimate chloride concentration changes that would occur as a result of implementation of changed water conveyance features under conservation measure CM1 for the alternatives.

In addition, the implementation conservation measure CM4 would restore substantial areas of tidal habitat that would increase the magnitude of daily tidal water exchange at the restoration areas, and could alter other hydrodynamic conditions in adjacent Delta channels. San Francisco Bay water is a major source of chloride, thus, the increased tidal exchange resulting from tidal habitat restoration may increase chloride concentrations in the portion of the Bay water that enters the western Delta. The DSM2 modeling included assumptions regarding possible locations of tidal habitat restoration areas, and how restoration would affect Delta hydrodynamic conditions and source water flow fractions. However, the magnitude of increased chloride concentrations in Bay source water in the western Delta as a result of increased tidal exchange is uncertain. Consequently, the potential effects of tidal restoration on chloride concentrations in the Bay source water was assessed qualitatively based on predicted changes in the Bay source water fraction. The effects of other conservation measures (i.e., CM2, CM3, and CM5–CM22) which do not substantially affect flows or Delta hydrodynamic conditions also were assessed qualitatively.

Table 8-49 provides a summary of chloride concentrations in the primary source waters of the Delta used for the mass-balance approach, as well as information on the source of the data and summary statistics. The long-term average source water concentrations were used for most locations in the mass-balance assessment; however, due to the presence of a distinct seasonal pattern in the chloride concentrations of the San Francisco Bay source water at the interface with the Delta in relation to seasonal Delta outflow pattern, monthly average concentrations were used for this location.

The mass-balance modeling results were used to compare predicted changes in assessment variables (e.g., exceedances of objectives/criteria, amount of water quality degradation relative to chloride) based on averaging periods appropriate for each relevant beneficial use. The assessment of effects relative to designated beneficial uses and associated water quality objectives/criteria was based on changes in long-term average concentrations modeled for all water year types for the 16-year (1976–1991) hydrologic period of record and for the drought years only (i.e., 1987–1991). Compliance for some applicable objectives/criteria are based on short-term averaging period concentrations; e.g., daily data for Bay-Delta WQCP objectives for municipal and industrial water supply for specific locations in the Delta (e.g., daily data) and the U.S. EPA aquatic life criteria (i.e., 4-day chronic and 1-hour acute criteria). The available monitoring data for source water chloride concentrations are not adequate to characterize daily variability, and the channel flows modeled in CALSIM, which provides the hydrologic input to the DSM2 model, is on a monthly time-step. Therefore, the mass-balance approach for the chloride assessment is not sufficiently sensitive to evaluate potential exceedances, or degradation, with respect to the short-term averaging periods applicable to these objectives. Consequently, the assessment of potential effects of alternatives relative to these objectives/criteria was based on monthly average concentrations from the mass-balance approach. However, EC concentrations are modeled directly in the DSM2 model which runs on a sub-daily time-step, and EC and chloride concentrations are closely correlated in the affected environment. Consequently, the direction and relative magnitude of EC changes predicted by DSM2 modeling also were reviewed qualitatively for the chloride assessment to support the conclusions regarding chloride changes predicted by the mass-balance approach.

Table 8-48. Applicable Federal Criteria, State Objectives, and Other Relevant Effects Thresholds for Chloride (mg/L unless specified)

Location	Bay-Delta WQCP		Region 5 Basin Plan	Region 2 Basin Plan	Drinking Water MCL	U.S. EPA Recommended Criteria
All Receiving Waters Other Than the Delta	- -		250 [a, b] 500 [a, c] 600 [a, d]	142/355 [e] 250 [a, b] 500 [a, c] 600 [a, d]	250 [b] 500 [c] 600 [d]	230/860 [f]
Delta-Specific						
Contra Costa Canal @ Pumping Plant No. 1 or San Joaquin River @ Antioch Water Works Intake	Year Type	Objective [g]	- -	- -	- -	- -
	W	<150–240 days/calendar year (66%)				
	AN	<150–190 days/calendar year (52%)				
	BN	<150–175 days/calendar year (48%)				
	D	<150–165 days/calendar year (45%)				
	C	<150–155 days/calendar year (42%)				
Contra Costa Canal @ Pumping Plant #1, West Canal @ Mouth of Clifton Court Forebay, Jones Pumping Plant, Barker Slough @ North Bay Aqueduct, and Cache Slough @ the City of Vallejo Intake	250 (Oct.–Sep.) [h]		- -	- -	- -	- -

Notes:

[a] State secondary maximum contaminant level (MCL) incorporated by reference in the Basin Plan. No fixed consumer acceptance contaminant level has been established. Municipal water systems must monitor for compliance based on a running average of four quarterly values. The Region 5 Basin Plan incorporates the MCLs by reference, but do not specify an averaging period for assessment of compliance.

[b] Recommended Contaminant Level for the state secondary MCL. Constituent concentrations lower than the recommended contaminant level are desirable for a higher degree of consumer acceptance.

[c] Upper Contaminant Level for the state secondary MCL. Constituent concentrations ranging to the upper contaminant level are acceptable if it is neither reasonable nor feasible to provide more suitable waters.

[d] Short Term Contaminant Level for the state secondary MCL. Constituent concentrations ranging to the short term contaminant level are acceptable only for existing community water systems on a temporary basis pending construction of treatment facilities or development of acceptable new water sources.

[e] Objectives for agricultural water supply identified in Basin Plan as a "threshold value/limit value"; no averaging period is defined for assessment of compliance.

Location	Bay-Delta WQCP	Region 5 Basin Plan	Region 2 Basin Plan	Drinking Water MCL	U.S. EPA Recommended Criteria

[f] U.S. EPA National Recommended Water Quality Criteria specified as Criterion Continuous Concentration (CCC)/Criteria Maximum Concentration (CMC).

[g] Municipal and industrial water supply beneficial use objective, specified as a maximum mean daily value for at least the number of days shown during the calendar year. Must be provided in intervals of not less than two weeks duration (percentage of calendar year shown in parentheses).

[h] Municipal and industrial water supply beneficial use objective, specified as a maximum mean daily value to be applied year-round for all water year types.

Need to define Water Year Types

A = Annual, etc.

Table 8-49. Historical Chloride (Dissolved) Concentrations in the Five Delta Source Waters

Source Water	Sacramento River	San Joaquin River	San Francisco Bay [a]	East Side Tributaries	Delta Agriculture Return Waters [b]
Mean (mg/L)	6.38	81.4	3,757–9,414	2.36	136
Minimum (mg/L)	1.00	1.00	8–4,990	0.30	3.0
Maximum (mg/L)	33.0	221	9,710–12,600	8.60	830
75th Percentile (mg/L)	8.00	111	6,375–11,000	3.05	175
99th Percentile (mg/L)	12.3	186	9,643–1,2574	5.79	636
Data Source	DWR, BDAT	DWR, BDAT	BDAT	USGS	DWR
Station(s)	Sac River at Greene's Landing, Sac River at Hood	SJR at Vernalis	Suisun Bay at Bulls Head near Martinez	Mokelumne River, Cosumnes River	[b]
Date Range	1980–2009	1980–2009	1980–2007	1952–1994	1987–2001
ND Replaced with RL	No	No	No	No	No
Data Omitted	None	None	None	Single <0.1 value from each data set, 0 values from Cosumnes River	None
No. of Data Points	867	844	26–27	391	1,543

[a] Values reported as range of monthly values (minimum monthly–maximum monthly). Review of available sample data for the Martinez location suggests that there is a generally seasonal trend in monthly average chloride concentration.
Chloride concentrations used to represent San Francisco Bay water in the mass-balance assessment were determined on a monthly average basis. Refer to Appendix 8G, Table Cl-41 for additional information and tabulation of the calculated monthly average chloride concentrations for the Bay source water.

[b] Values calculated from all agriculture drain data pooled together. All chloride data from agricultural drains contained in the DWR Water Data Library were placed into a single database.

Seasonal or long-term changes in chloride concentrations at western Delta locations would be associated with changes in the location of the tidal mixing zone and interface of the elevated Bay salt water and freshwater Delta outflow. Changes in the salt water/freshwater interface may result in shifts of the acceptability of a location between freshwater- and salinity-tolerant aquatic fish, aquatic vegetation, and other aquatic organisms. The significance of these potential effects relative to applicable freshwater and estuarine water quality objectives is not assessed in the chloride assessment. Rather, the reader is referred to the "Fisheries and Aquatic Resources" chapter for the detailed assessment of changes in the location of the tidal mixing zone (e.g., as measured by the location of X2) and for its impact(s) to aquatic life beneficial uses.

Dissolved Oxygen

Dissolved oxygen (DO) is a measure of the amount of oxygen that is present in the water column, and thus available to support aquatic life. Water gains oxygen from the atmosphere and from aquatic plant photosynthesis. DO in water is consumed through respiration by aquatic animals, decomposition of plant and animal material (microbial respiration), sediment oxygen demand, and various chemical processes. DO depletion primarily affects aquatic life beneficial uses, which include Warm Freshwater Habitat, Cold Freshwater Habitat, Migration of Aquatic Organisms, Spawning, Reproduction, and/or Early Development, Estuarine Habitat, and Rare, Threatened, or Endangered Species. The most sensitive receptors include Cold Freshwater Habitat, Migration of Aquatic Organisms (Cold), Spawning, Reproduction, and/or Early Development (Cold) due to the relatively high DO requirements of coldwater fish, such as Chinook salmon and steelhead. Low DO levels in water bodies can have adverse affects on aquatic life, including fish kills, fish egg mortality, and growth rate reductions, and, under sufficiently elevated temperature conditions, can create a barrier to migration of anadromous fish such as Chinook salmon (CalEPA 2005; Schmieder *et al.* 2008).

Seasonal declines in DO are typical in many estuaries, and DO levels can be negatively affected by increases in water temperature (Schmieder *et al.* 2008). Nutrient loading from point and nonpoint sources can result in increased algal growth, thereby causing higher DO levels when blooms are photosynthesizing and lowering DO levels during night time hours and when the blooms die and decompose (Schmieder *et al.* 2008). Activities that disturb sediments and aquatic plants such as dredging and clearing of aquatic plants from ship channels can cause increased decomposition of organic material, resulting in decreases in DO levels (Greenfield *et al.* 2007; Schmieder *et al.* 2008). However, removal of aquatic plants, especially invasive plant species, may allow light to better penetrate the water column, increasing photosynthesis by phytoplankton and thereby increasing DO levels (Greenfield *et al.* 2007).

The 2006 Bay-Delta WQCP, Region 2 Basin Plan, and Region 5 Basin Plan all contained DO objectives applicable to water bodies in the affected environment. A DO objective for protection of Fish and Wildlife Beneficial Uses exists in the 2006 Bay-Delta WQCP for the San Joaquin River between Turner Cut and Stockton: 6.0 mg/L from September through November (State Water Board 2006a). The Region 5 Basin Plan has the same objective for the San Joaquin River and the Region 2 Basin Plan incorporates by reference the DO objectives in the 2006 Bay-Delta WQCP (Central Valley Regional Water Quality Control Board 2009; San Francisco Bay Regional Water Quality Control Board 2007). The Region 5 Basin Plan contains the following additional numerical DO objectives for the Delta (Central Valley Regional Water Quality Control Board 2009).

- At least 7.0 mg/L in the Sacramento River below the I Street bridge and west of the Antioch Bridge.
- At least 5.0 mg/L at all other locations and times, unless the water body has been constructed for special purposes and fish are excluded or not important as a beneficial use.

In addition, the Region 5 Basin Plan requires that water bodies outside the legal boundary of the Delta meet certain saturation levels and not be reduced below the following levels at any time.

- Waters designated WARM, 5.0 mg/L.
- Waters designated COLD, 7.0 mg/L.
- Waters designated SPWN, 7.0 mg/L.

The Region 2 Basin Plan also has minimum DO objectives for warm and cold water habitat of 5.0 mg/L and 7.0 mg/L, respectively (San Francisco Bay Regional Water Quality Control Board 2007). Lastly, the Region 5 Basin Plan contains a DO objective for the Sacramento River from Keswick Dam to Hamilton City of 9.0 mg/L (or 95% saturation) from 1 June to 31 August, and an objective of 8.0 mg/L for the Feather River from Fish Barrier Dam at Oroville to Honcut Creek from 1 September to

31 May (Central Valley Regional Water Quality Control Board 2009). There are no DO criteria in the National Toxics Rule or CTR (as it is not a priority pollutant), nor is there a California drinking water MCL for DO.

Water bodies in the affected environment listed on the state's Clean Water Act section 303(d) list as impaired due to low DO levels include Middle River, Old River, the Stockton Deep Water Ship Channel and portions of other sloughs and rivers in the southern, eastern, and western (State Water Board 2011). A TMDL for the Stockton Deep Water Ship Channel was approved by U.S. EPA on 27 February 2007, and includes a Region 5 Basin Plan Amendment that includes a Control Program to reduce the amount of oxygen demanding substances and their precursors in the San Joaquin River. The TMDL takes a phased approach to allow more time to gather additional informational on source and linkages to the DO impairment, while at the same time moving forward on making improvements to DO conditions. TMDLs for listed water bodies are proposed for completion in 2012 through 2021(State Water Board 2011).

Electrical Conductivity

Electrical conductivity (EC) is an analytical measure of the ability of water to conduct an electric current which characterizes salinity levels in water, where salinity is produced primarily by inorganic cations (e.g., calcium, magnesium, sodium, and potassium) and anions (e.g., sulfate, chloride, fluoride, bromide, and bicarbonate/carbonate). EC units commonly used are micromhos/cm (μmhos/cm) and milliSiemens/cm (mS/cm).

Sources of salinity in the affected environment include natural geochemical weathering and dissolution of soils and minerals, tidal seawater intrusion in the Delta, prehistoric seawater (i.e., connate) trapped in deep groundwater aquifers, and anthropogenic discharges (e.g., domestic wastewater, urban runoff, and agricultural wastewater and drainage). Seawater intrusion to the western Delta is the largest potential source of concern because it has exceedingly higher salinity than freshwater, such as the very low levels of the Sacramento River which provides the largest source of freshwater to the Delta. CVP and SWP water supply operations are managed to control freshwater inflows and Delta outflow to repel the salinity intrusion in the western Delta and comply with Bay-Delta WQCP regulatory objectives. Salinity also can naturally increase due to evaporation from water bodies, or evapotranspiration from agricultural crops and other vegetation (e.g., wetlands, riparian vegetation) which results in concentrated drainage-related salinity contribution. The recirculation and evaporative concentration of salts is a factor that results in generally higher salinity levels in San Joaquin River flows and Delta island drainage.

Water supplies for irrigated agriculture, municipal drinking water, and industrial processes are the most sensitive beneficial uses to increasing salinity in freshwater. The sensitivity of agricultural crops to salinity varies considerably and depends on many factors such as the plant type and age, seasonality, and specific constituents causing the salinity (e.g., chloride and sodium can cause more severe effects than other ions). Salinity constituents generally impart unpalatable tastes in drinking water and result in higher costs from corrosion or the necessity for additional treatment. Many freshwater aquatic organisms also are sensitive to salinity, and in particular the interface between freshwater and tidal seawater in the western Delta can influence the composition and habitat quality of marine, estuarine, and freshwater organisms.

EC and TDS values tend to be highly correlated, because the majority of chemicals that contribute to TDS are charged particles that impart conductance of water. Because EC measurement is easily conducted with a portable meter, as compared to the requirement for physical sample collection and laboratory gravimetric analysis for TDS, the majority of water quality regulatory criteria/objectives are established for EC. Moreover, where regulatory objectives for TDS exist, they co-occur with the equivalent EC value (i.e., there are no independent TDS-only regulatory criteria/objectives or guidance values). EC also is the parameter modeled to represent salinity in DSM2. Therefore, this impact assessment for "salinity" as indicated by EC and TDS is based on EC values only and TDS is not addressed separately.

Applicable EC objectives for the affected environment are summarized in Table 8-50. Because EC is not a priority pollutant, there are no criteria established for EC in the National Toxics Rule or CTR. The Region 5 Basin Plan specifies EC objectives for Sacramento River, Feather River, and San Joaquin River; it also contains EC objectives for the Delta which have been superseded by the 2006 Bay-Delta WQCP. The Bay-Delta WQCP contains EC objectives for the Delta for agricultural and fish and wildlife beneficial use protection, which vary by month and water year type. The Bay-Delta WQCP EC objectives for agricultural protection are designed to primarily control salinity conditions in the interior and southern Delta channels, and San Joaquin River inflow to the Delta at Vernalis, which tend to have higher salinity concentrations and are influenced most by Delta exports. The Region 2 Basin Plan contains agricultural EC objectives; however, the affected environment of the Delta and downstream Bay waters within Region 2 are generally saline and do not likely serve as a major water source for agricultural activity. For the protection of fish and wildlife habitat, the Bay Delta WQCP regulates EC in western and interior Delta locations and Suisun Marsh.

Multiple water bodies in the affected environment are on the state's CWA Section 303(d) list for impairment by elevated EC levels, as follows: (a) southern, northwestern, and western channels in the Delta; (b) Delta export area; (c) Grasslands drainage area, Mud Slough, and Salt Slough in the San Joaquin River valley; (d) San Joaquin River from Bear Creek to Delta boundary; and (e) Suisun Marsh (State Water Resources Control Board 2011). A TMDL has been prepared for the lower San Joaquin River at Vernalis, and the TMDL for segments upstream from Vernalis is under development.

The assessment of effects on EC in the reservoirs and rivers upstream of the Delta was qualitative, and evaluates changes in EC based on anticipated changes in EC-contributing sources in the watersheds under the various BDCP alternatives assessed.

The assessment of hydrodynamic effects of the BDCP alternatives' CM1, CM2, and CM4 on EC in the Plan Area relied on DSM2 output. Because implementation CM4 would restore substantial areas of tidal habitat that would increase the magnitude of daily tidal water exchange at the restoration areas, and could alter other hydrodynamic conditions in adjacent Delta channels, the DSM2 modeling included assumptions regarding possible locations of tidal habitat restoration areas, and how restoration would affect Delta hydrodynamic conditions and source water flow fractions. The effects of other conservation measures (i.e., CM3 and CM5–CM22) which do not substantially affect Delta hydrodynamic conditions were assessed qualitatively.

DSM2 directly models Delta EC levels on a 15-minute interval. DSM2 output for EC was post-processed to compare results to the Bay-Delta WQCP objectives at the following locations.

Western Delta: Sacramento River at Emmaton and San Joaquin River at Jersey Point

Interior Delta: South Fork Mokelumne River at Terminous, San Joaquin River at San Andreas Landing, and San Joaquin River at Prisoners Point

Southern Delta: San Joaquin River at Vernalis, San Joaquin River at Brandt Bridge, Old River near Middle River, and Old River at Tracy Road Bridge

For the assessment of Alternatives 1–9, the Sacramento River at Emmaton compliance location is relocated to Three Mile Slough near the Sacramento River. For comparing effects of the alternatives on EC in this portion of the Delta, changes in EC in Three Mile Slough under the alternatives are compared to EC at Emmaton under existing conditions and the No Action Alternative NT and LLT. The western and interior Delta EC objectives are expressed as a 14-day running average, and the southern Delta EC objectives are expressed as a 30-day running average. Compliance with these EC objectives was assessed by calculating 14-day and 30-day running averages of the 15-minute DSM2 EC results and tallying the number of days out of compliance with the applicable objective. The Bay-Delta WQCP considers all days in an averaging period out of compliance. Because this could overestimate the general change in EC at compliance locations, the number of days the EC objective was exceeded was also assessed to identify general trends in EC changes under the alternatives assessed.

The effects on EC in SWP/CVP Export Service Areas also relied on DSM2 output. For assessment of alternatives involving conveyance of north Delta water to the Banks and Jones pumping plants, DSM2 results for the south Delta pumping plant locations were blended, or mass-balanced, with modeled north Delta diversions to provide an estimate of the EC of the water conveyed by these pumping plants to the SWP/CVP Export Service Areas south of the Delta. The resulting blended monthly mean EC levels were compared to the Bay-Delta WQCP objectives for the export areas, which are the objectives for protection of the agricultural beneficial uses in the south Delta SWP/CVP Export Service Areas.

Assessment of Suisun Marsh EC was conducted qualitatively, utilizing average EC for the entire period modeled (1976–1991) to determine the overall change and degree to which EC could be affected by the alternatives. The Suisun Marsh locations utilized in the analysis correspond to the EC compliance locations in the Bay-Delta WQCP: Sacramento River at Collinsville, Montezuma Slough at National Steel, Montezuma Slough near Beldon Landing, Chadbourne Slough at Sunrise Duck Club, and Suisun Slough 300 feet south of Volanti Slough. These locations represent a geographic range from which to assess changes.

Understanding some basic input assumptions for DSM2 is important for interpreting the results and effects analysis, including assessment of compliance with water quality objectives. While DSM2 simulates EC on a 15-minute time-step, the Delta inflow and agricultural return flow inputs, and Delta operations (e.g., Delta Cross Channel gate operations) inputs to DSM2 are on a monthly time-step. Because the DSM2 inputs are on a monthly time-step, the assessment of compliance with sub-monthly objectives (e.g, 14-day running averages) is conducted in terms of assessing the overall direction and degree to which Delta EC would be affected relative to a baseline, and discussion of compliance does not imply that the alternative would literally cause Delta EC to be out of compliance a certain period of time. In other words, the model results are used in a comparative mode, not a predictive mode.

1 **Table 8-50. Applicable State Objectives and Other Relevant Effects Thresholds for Electrical Conductivity (µmhos/cm[at 25°C] unless specified)**

Location	Bay-Delta WQCP		Region 5 Basin Plan	Region 2 Basin Plan	Drinking Water MCL
All Receiving Waters Other than the Delta	- -		900 [a, b] 1,600 [a, c] 2,200 [a, d]	200-3,000 [e] 900 [f]	900 [a, b] 1,600 [a, c] 2,200 [a, d]
Delta-Specific	Year Type	Objective [g] for Agricultural Beneficial Uses			
Western Delta - Sacramento River @ Emmaton	W	450 (Apr. 1–Aug. 15)	- -	- -	- -
	AN	450 (Apr. 1–Jun. 30); 630 (Jul. 1–Aug 15)			
	BN	450 (Apr. 1–Jun. 19); 1,140 (Jun. 20–Aug 15)			
	D	450 (Apr. 1–Jun. 14); 1,670 (Jun. 15–Aug 15)			
	C	2,780 (Apr. 1–Aug. 15)			
Western Delta - SJR @ Jersey Point	W	450 (Apr. 1–Aug. 15)	- -	- -	- -
	AN	450 (Apr. 1–Aug. 15)			
	BN	450 (Apr. 1–Jun. 19); 740 (Jun. 20–Aug 15)			
	D	450 (Apr. 1–Jun. 14); 1,350 (Jun. 15–Aug 15)			
	C	2,200 (Apr. 1–Aug. 15)			
Interior Delta - S.F. Mokelumne @ Terminous	W	450 (Apr. 1–Aug. 15)	- -	- -	- -
	AN	450 (Apr. 1–Aug. 15)			
	BN	450 (Apr. 1–Aug. 15)			
	D	450 (Apr. 1–Aug. 15)			
	C	540 (Apr. 1–Aug. 15)			
Interior Delta - SJR @ San Andreas Landing	W	450 (Apr. 1–Aug. 15)	- -	- -	- -
	AN	450 (Apr. 1–Aug. 15)			
	BN	450 (Apr. 1–Aug. 15)			
	D	450 (Apr. 1–Jun. 24); 580 (Jun. 25–Aug 15)			
	C	870 (Apr. 1–Aug. 15)			
Southern Delta	Objective for Agricultural Beneficial Uses		- -	- -	-
	700 (Apr. 1–Aug. 31)				
	1,000 (Sep. 1–Mar. 31) [h]				

Location	Bay-Delta WQCP				Region 5 Basin Plan	Region 2 Basin Plan	Drinking Water MCL
Export Area	Objective for Agricultural Beneficial Uses				- -	- -	- -
	1,000 (Oct. 1–Sep. 30) [i]						
SJR at and between Prisoners Point and Jersey Point	Objective for Fish and Wildlife Beneficial Uses				- -	- -	- -
	440 (Apr. 1–May 31) [j]						
Eastern Suisun Marsh (Sacramento @ Collinsville; Montezuma Slough @ National Steel; Montezuma Slough near Beldon Landing)	Month	Objective [k] for Fish and Wildlife Beneficial Uses			- -	- -	- -
	Oct	19,000					
	Nov–Dec	15,500					
	Jan	12,500					
	Feb–Mar	8,000					
	Apr–May	11,000					
Western Suisun Marsh (Cadbourne Slough @ Sunrise Duck Club, Suisun Slough [300 ft south of Volanti Slough], Cordelia Slough at Ibis Club, Goodyear Slough at Morrow Is. Clubhouse, and water supply intakes for water fowl management areas on Van Sickle and Chipps Is.)	Month	Objective [l]	Month	Objective [m] for Fish and Wildlife Beneficial Uses	- -	- -	- -
	Oct	19,000	Oct	19,000			
	Nov	16,500	Nov	16,500			
	Dec	15,500	Dec–Mar	15,600			
	Jan	12,500	Apr	14,000			
	Feb–Mar	8,000	May	12,500			
	Apr–May	11,000					

Notes:

[a] State secondary maximum contaminant level (MCL). No fixed consumer acceptance contaminant level has been established. Municipal water systems must monitor for compliance based on a running average of four quarterly values. The Region 5 Basin Plan incorporates the MCLs by reference, but do not specify an averaging period for assessment of compliance.

[b] Recommended Contaminant Level. Constituent concentrations lower than the recommended contaminant level are desirable for a higher degree of consumer acceptance.

[c] Upper Contaminant Level. Constituent concentrations ranging to the upper contaminant level are acceptable if it is neither reasonable nor feasible to provide more suitable waters.

[d] Short Term Contaminant Level. Constituent concentrations ranging to the short term contaminant level are acceptable only for existing community

Location	Bay-Delta WQCP	Region 5 Basin Plan	Region 2 Basin Plan	Drinking Water MCL

water systems on a temporary basis pending construction of treatment facilities or development of acceptable new water sources.

[e] Objectives for agricultural water supply specified as a "limit" consisting of a range of concentrations and no averaging period is defined for assessment of compliance.

[f] Objective for municipal supply.

[g] Agricultural objective is a 14-day running average of mean daily EC.

[h] Agricultural objective is a maximum 30-day running average of mean daily EC. Objectives applicable to all southern Delta channels and specified compliance stations (i.e., San Joaquin River @ Airport Way Bridge-Vernalis, San Joaquin River @ Brandt Bridge, Old River near Middle River, and Old River @ Tracy Road Bridge).

[i] Agricultural objective is a maximum monthly average of mean daily EC. Compliance stations are West Canal @ Mouth of Clifton Court Forebay and Delta-Mendota Canal at Tracy Pumping Plant.

[j] Fish and wildlife objective is a maximum 14-day running average of mean daily EC.

[k] Fish and wildlife objectives for Sacramento @ Collinsville, Montezuma Slough @ National Steel, and Montezuma Slough near Beldon Landing. Compliance based on maximum monthly average of both daily high tide EC values, or demonstrate that equivalent of better protection will be provided at the location. Applies in all water year types except during deficiency period.

[l] Fish and wildlife objectives for Cadbourne Slough @ Sunrise Duck Club, Suisun Slough (300 ft south of Volanti Slough), Cordelia Slough at Ibis Club, Goodyear Slough at Morrow Is. Clubhouse, and water supply intakes for water fowl management areas on Van Sickle and Chipps Is. Compliance based on maximum monthly average of both daily high tide EC values, or demonstrate that equivalent of better protection will be provided at the location. Applies in all water year types except during deficiency period.

[m] A deficiency period is: (1) the second consecutive dry water year following a critical year; (2) a dry water year following a year in which the Sacramento River Index (described in footnote e) was less than 11.35; or (3) a critical water year following a dry or critical water year. The determination of a deficiency period is made using the prior year's final Water Year Type determination and a forecast of the current year's Water Year Type; and remains in effect until a subsequent water year is other than a Dry or Critical water year as announced on May 31 by DWR and U.S. Bureau of Reclamation (Reclamation) as the final water year determination.

Mercury

[*Note to Lead Agencies: Discussion in preparation*.]

Nitrate

Nitrate can be expressed as either NO_3 (nitrate) or NO_3-N (nitrate-nitrogen). Sources of nitrate to surface waters include municipal discharges, and agriculturaland urban runoff. In the aquatic environment nitrate may rapidly cycle between water, organisms, and sediments. Nitrate is also formed in the process of nitrification from ammonia. It is estimated that 75% of the ammonia present in the Sacramento River at Hood is converted to nitrate by the time the water reaches Chipps Island (Foe CVRWQCB 2010 Update memo:4).

Aquatic life depends on the availability of nutrients; however, elevated concentrations of nutrients such as nitrate can cause eutrophication, in which high algal and bacterial growth and subsequent microbial respiration deplete oxygen, producing anoxic waters and sediments. Waters of the Delta are not considered nutrient limited; that is, algal growth rates are limited by availability of light, and thus increases or decreases in nutrient levels are, in general, expected to have little effect on productivity (Jassby et al. 2002). However, when waters of the Delta are exported into conveyance canals, algae may no longer be light-limited, and thus increases in nutrient levels in Delta export waters may increase phytoplankton growth within the canals. Algal blooms are problematic in that they create biomass that can obstruct water conveyance facilities and clog filters, and they may also lead to taste and odor problems for municipal supplies (Sanitary Survey:3-69).

However, regarding the potential for taste and odor concerns, Lee (2008) summarized a presentation by P. Hutton (Metropolitan Water District), given at the March 25, 2008, California Water and Environmental Modeling Forum (CWEMF) "Delta Nutrient Water Quality Modeling Workshop", that stated: "there is limited ability to relate nutrient loads or in-channel concentrations to domestic water supply water quality. While there is some ability to model the relationship between the nutrient load to a waterbody and the planktonic algal biomass that develops in the waterbody, it is not possible to adequately model the relationship between nutrient load to a waterbody and the development of benthic and attached algae in that waterbody" (Lee 2008:6). This is important in that benthic and attached algae are potentially more important for taste and odor concerns than is planktonic biomass generally (Juttner and Watson 2007:1-2).

The beneficial uses most directly affected by nitrate concentrations include aquatic organisms (cold freshwater habitat, warm freshwater habitat, and estuarine habitat), drinking water supplies (municipal and domestic supply), and recreational activities (water contact recreation, non-contact water recreation), which can be indirectly affected by the nuisance eutrophication effects of nutrients.

There are no Clean Water Act section 303(d) listings for nitrate in the affected environment. U.S. EPA recommended criteria and state Basin Plan objectives and drinking water MCLs for nitrate are summarized in Table 8-XX. The relevant Region 2 Basin Plan objectives include: 30 mg/L nitrate-N for irrigation water, and 100 mg N/L nitrate-N for livestock watering. A drinking water maximum contaminant level for nitrate-N is 10 mg N/L because it can compete with oxygen for receptor sites on hemoglobin in the bloodstream, thereby interfering with normal oxygen transport by the blood and causing effects in humans, particularly infants, such as "blue-baby syndrome." Another threshold for nitrate-N is for irrigation water as recommended by Ayers and Westcot (1985), who recommend a value of 5 mg/L nitrate-N for sensitive crops (e.g. sugar beets, grapes, apricot, citrus, avocado, grains). The concern for these crops is that too much nitrate may cause greater growth than desired, diluting sugars and flavors and thus lowering the value of the crop. However, at levels below 5 mg/L-N, it is assumed that nitrate is beneficial for these crops, and thus increases below the 5 mg/L-N threshold are generally not of concern for agriculture. It should be noted that this 5 mg/L-N Ayers and Westcot (1985) threshold has not been identified as a recommended criterion by U.S. EPA, nor has it been adopted by the state as a water quality objective.

Table XX. Applicable Federal Criteria, State Objectives, and other Relevant Effects Thresholds for nitrate (mg N/L)

	Region 5 Basin Plan	Region 2 Basin Plana	CTR	Drinking Water MCL	USEPA Recommended Criteria	Other Relevant Thresholdsb
Nitrate-N	--	30 100	--	10	10c	5

a SFRWQCB (2007). 30 mg/L nitrate-N criterion for irrigation water; 100 mg/L nitrate-N criterion for livestock watering.

b Ayers and Westcot (1985). Recommended goals for sensitive crops.

c For the consumption of water and organisms.

Table XY characterizes nitrate concentrations in source waters to the Delta. Data indicate that the San Joaquin River and agriculture within the Delta contain the highest nitrate concentrations, while concentrations in the Sacramento River, San Francisco Bay, and East Side Tributaries are considerably lower. Both the Sacramento and San Joaquin Rivers exhibit seasonal patterns in nitrate concentration.

Table XY. Nitrate Concentrations in the Source Waters to the Delta

Source Water	Sacramento River [a]	San Joaquin River [a]	San Francisco Bay	East Side Tributaries	Agriculture within the Delta [a, b]
Mean (mg/L as N)	0.068 - 0.209	0.791 - 1.839	0.07	0.17	0.059 - 3.833
Minimum (mg/L as N)	0.023 - 0.113	0.068 - 1.175	0.026	0.010	0.002 - 0.339
Maximum (mg/L as N)	0.136 - 0.553	2.123 - 3.614	0.12	1.70	0.135 - 54.644
75th Percentile (mg/L as N)	0.09 - 0.248	1.017 - 2.169	0.09	0.16	0.068 - 4.516
99th Percentile (mg/L as N)	0.122 - 0.545	1.992 - 3.479	0.12	0.99	0.133 - 34.182
Data Source	DWR	DWR	SFEI	USGS	DWR
Station(s)	Sac River at Greene's Landing, Sac River at Hood	SJR at Vernalis	BD40 (Just W. of Carquinez Straight)	Mokelumne River, Cosumnes River	See footnote [b]

Source Water	Sacramento River [a]	San Joaquin River [a]	San Francisco Bay	East Side Tributaries	Agriculture within the Delta [a, b]
Date Range	1997 - 2008	1990 - 2009	1993 - 2001	1961 - 1993	1990 - 2001
ND Replaced with RL	No	No	No	No	Yes
Data Omitted	Data prior to 1992 (EPA Method 353.2; poor detection limit)	Two values > 9 mg/L as N	None	Values reported as "0"	None
No. of Data Points	25 - 33	29 - 35	25	45	5 - 81

[a] Values reported as range of monthly values (minimum monthly – maximum monthly). Trends in monthly average nitrate at these locations suggested a seasonality to concentration. Due to the appearance of seasonality in monthly average concentration at these locations, average monthly concentration was used. Tables of these parameters by month are show in the Nitrate Appendix, Appendix J.

[b] Values calculated from all agriculture drain data pooled together. All nitrate data from agricultural drains contained in the DWR Water Data Library were placed into a single database. Due to the uneven distribution of agricultural drains in the Delta, geographical trends in agricultural drain water quality were evaluated by categorizing the data based on their associated location in the Delta. Categories included western, southern, northern, eastern, and central Delta, following the geographical delineations of the State Water Resources Control Board. With data pooled and categorized by region, average concentration by region were compared. Average nitrate did not vary greatly between regions. Due to the apparent low regional variability, values were obtained by pooling all data together and obtaining summary statistics from this pooled database.

As mentioned above, nitrate does not behave conservatively in the environment. It can be created via conversion from ammonia to nitrate and can be taken up and metabolized by organisms and sediments. However, because nitrate concentrations vary considerably between the source waters to the Delta, conservative modeling was employed to provide a characterization of changes in nitrate concentration anticipated as a result of changes in source water fractions throughout the Delta alone (using mean concentrations from Table XY, above). Addition and loss mechanisms are considered qualitatively in the context of the quantitative mixing results to characterize changes in nitrate concentrations under the alternatives assessed.

Organic Carbon

In an aquatic system, organic carbon encompasses a broad range of compounds, all of which fundamentally contain carbon in their structure. Organic carbon typically enters an aquatic system through the decay of plant and animal materials, occurs naturally in the environment, and forms a critical part of the aquatic food web (USEPA 2006). Methodologically, a measurement of total organic carbon (TOC) represents the sum of both particulate organic carbon (POC) and dissolved organic carbon (DOC). Aside from its food web importance, organic carbon is an important disinfection by-product (DBP) precursor, and thus is an important parameter describing the quality of water for use as a drinking water source. When subject to disinfectants like chlorine, chemicals such as trihalomethanes(THMs) and haloacetic acids can be formed.

The regulated THMs, known at Total THMs (TTHMs), are chloroform, bromodichloromethane, dibromochloromethane, and bromoform. THMs are colorless, volatile, dissolve easily in water, and are fairly stable (USBR 2003). The regulated haloacetic acids (HAAs), known as HAA5, are monochloroacetic acid, dichloroacetic acid, trichloroacetic acid, monobromoacetic acid, and dibromoacetic acid. HAAs are colorless, have a low volatility, dissolve easily in water, and are fairly stable (USBR 2003). THMs and HAAs are known to cause liver, kidney, and central nervous system problems and pose an increased risk of cancer (USEPA 2008a) when consumed at low levels over a lifetime. Environmental concerns regarding THMs and HAAs are primarily related to the consumers (humans, animals) of drinking water containing HAAs and THMs.

Data analyzed as part of the Screening Analysis section indicated that THMs and HAAs themselves were far below levels of concern in the affected environment. However, data on THM or HAA formation potential, which is measured by chlorinating a water sample and then measuring the THMs and HAAs produced, was available, and THM and HAA results from these samples were at times above criteria.

A study assessing organic carbon, bromide, and THM formation potential in the California Aqueduct found that TOC concentration was a good predictor of THM formation potential at the Banks pumping plant, the Delta Mendota Canal (DMC, which feeds the Jones pumping plant), and several locations along the California Aqueduct (California Department of Water Resources 2005). The study did not measure DOC. Data collected from August 1998 at various Delta locations (MWQI 2003, p. 62 Table 4-3) indicated a strong positive relationship between DOC and HAA formation potential ($r^2 = 0.996$).

Given the strong link between THM and HAA formation potential and organic carbon, THM and HAA formation potential will not be assessed separately, but rather the assessment of organic carbon addresses concerns regarding THM and HAA formation potential. The relative potency of organic carbon as a DBP precursor can vary considerably across samples (CALFED Bay-Delta Program 2008:5), but in the Delta it is generally believed that the dissolved fraction (i.e., DOC) most frequently influences DBP formation potential (CALFED Bay-Delta Program 2007:5–22). But even within the DOC fraction, DBP formation can vary considerably, indicating that the nature of the organic matter that comprises DOC in a sample is important. Nevertheless, DOC is considered a more accurate surrogate for DBP formation relative to TOC or POC.

In Delta waters, DOC typically represents 85–90% of TOC (CALFED Bay-Delta Program 2007:5–22). In other words, practically all of the organic carbon in a typical sample is DOC. Sources of organic carbon are diverse, including upland, agricultural and urban runoff, wetlands, algae production, and treated municipal wastewaters. Dissolved organic carbon is present in all the streams and rivers flowing into the Delta and it is these upstream sources that supply the majority of the organic carbon load to the Delta. It has been estimated that between 50 and 90% of the DOC load entering the Delta arrives from upstream sources (CALFEDBay-Delta Program 2008:6). There are also sources internal to the Delta, such as agricultural drains and wetlands that, on an annual average basis, provide nearly 25% of the DOC load. These upstream and internal loads, and their related sources, vary by season, but DOC in the Delta typically peaks in the winter months, when seasonal river and Delta agricultural drain DOC loading are their greatest. Related to particular in-Delta sources, loading of DOC from agricultural drains is typically greatest in the winter, while loading from wetlands is greatest in the spring and summer (Fleck et. al. 2007:1; Deverel et al. 2007:18).

Organic carbon is not a priority pollutant; thus, the CTR has no criteria. There are no state or federal regulatory water quality objectives/criteria for organic carbon, nor any U.S. EPArecommended criteria. As a consequence, none of the water bodies in the affected environment are listed as impaired on the state's Clean Water Act section 303(d) list because of elevated organic carbon. However, under EPA's Disinfectants and Disinfection Byproducts Rule (EPA 1998), municipal drinking water treatment facilities are required to remove specific percentages of TOC in their source water through enhanced treatment methods, unless the drinking water treatment system can meet alternative criteria. EPA's action thresholds begin at 2–4 mg/L TOC and, depending on source water alkalinity, may require a drinking water utility to employ treatment to achieve as much as a 35% reduction in TOC. Where source water TOC is between 4–8 mg/L TOC, drinking water utilities may be required to achieve a 45% reduction in TOC. Existing Delta water quality regularly exceeds 2 mg/L DOC, and existing treatment plants already are obligated to remove some amount of TOC. Nevertheless, changes in source water quality at municipal intakes may trigger additional enhanced TOC removal, and associated increased treatment costs.

In addition to EPA's Disinfectants and Disinfection Byproducts Rule, the CALFED Drinking Water Program established a goal for TOC 3 mg/L as a long-term average as applied to municipal drinking water intakes drawing water from the Delta (CALFED Bay-Delta Program 2000). The goal was established based on a study prepared by CUWA recommending Delta source water quality targets sufficient to achieving DBP criteria in treated drinking water and sufficient to allow continued flexibility in treatment technology. Specifically, the goal of the CALFED Drinking Water Program is to:

> "achieve either: (a) average concentrations at Clifton Court Forebay and other southern and central Delta drinking water intakes of 50 μg/L bromide and 3.0 mg/L total organic carbon, or (b) an equivalent level of public health protection using a cost-effective combination of alternative source waters, source control, and treatment technologies."

Dissolved organic carbon measured in the Sacramento River shows a trend of gradually increasing DOC with distance from Shasta Dam, where median concentrations of about 1 to 1.5 mg/L increase to about 1.5 mg/L to 2 mg/L at Hood (CALFED Bay-Delta Program 2007:5–58). Major tributaries such as the Feather and American rivers contain relatively low DOC as well, with median measured concentrations of 1.5 mg/L-2 mg/L. Dissolved organic carbon on the lower San Joaquin River is comparatively greater, but generally decreases with downstream distance, where median concentrations at Stevinson are nearly 6 mg/L and median concentrations at Vernalis are about 3 mg/L (CALFED Bay-Delta Program 2007:5–49). This decrease in DOC can be attributed to inputs from tributaries such as the Merced, Tuolumne, and Stanislaus rivers, with median DOC concentrations of 2 mg/L.

Table 8-51 provides a summary of DOC concentrations for the Sacramento and San Joaquin Rivers as utilized for DSM2 boundary conditions. As discussed in the Methods For Analysis section (Section 8.3.1 above), DSM2 was utilized directly to model and predict DOC at 11 locations across the Delta, and the degree DOC changed under the various project alternatives. Because DOC is a precursor to the formation of DBPs which represent a long-term risk to human health, and because the existing source water quality goal is based on a running annual average, the quantitative assessment focuses on the degree to which an alternative may result in change in long-term average DOC concentrations at select locations upstream of the Delta, within the Delta, and in the SWP/CVP Export Service Areas. For municipal intakes located in the Delta interior, assessment locations at Contra Costa Pumping Plant No.1 and Rock Slough are taken as representative of Contra Costa's intakes at Rock Slough, Old River and Victoria Canal, and the assessment location at Barkley Cove is taken as representative of the City of Stockton's intake on the San Joaquin River. Municipal intakes at Mallard Slough, City of Antioch, and the North Bay Aqueduct are represented by their respective assessment locations. For the purposes of this assessment, effects within the SWP/CVP Export Service Areas are assessed based on DOC concentrations at the primary SWP and CVP Delta export locations (i.e., Banks and Jones pumping plants).

Table 8-51. Monthly Average Dissolved Organic Carbon Utilized in DSM2 Modeling for Sacramento and San Joaquin River Source Waters (mg/L)

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Sacramento at Hood	1.8	2.3	2.9	3.0	2.9	2.7	2.4	2.0	1.8	1.8	1.8	1.8
San Joaquin at Vernalis	3.4	3.5	3.6	4.7	4.8	4.7	3.9	3.4	3.4	3.4	3.4	3.4

In establishing its source water goal for organic carbon, CALFED assumed more stringent DBP criteria for treated drinking water than are currently in place. Source water with TOC between 4 and 7 mg/L is believed sufficient to meet currently established drinking water criteria for DPBs, depending on the amount of *Giardia* inactivation required (CUWA 1998, ES2). In light of these source water goals and TOC removal action thresholds, the assessment of alternatives evaluates how each alternative would affect the frequency with which predicted future organic carbon concentrations would exceed 2, 3, and 4 mg/L on a long-term average basis at the assessment locations. Because, in many cases, the existing condition is one already exceeding 2 and 3 mg/L, the frequency with which bromide exceeds 4 mg/L becomes a key focus of the assessment, as well the change in long-term average bromide concentration.

While existing goals and action threshold for organic carbon as a DBP precursor are expressed as TOC, it is the dissolved fraction, expressed as DOC, which is the focus of this assessment. As previously stated, 85–90% of Delta TOC is in the DOC or "dissolved" form, and it is the DOC fraction that more closely correlates to DBP formation potential. Furthermore, DOC in the Delta is generally considered to act conservatively; thus, the mass-balance modeling approach employed. Moreover, the POC fraction would be largely removed through conventional drinking water treatment (Archibald Consulting et al. 2007:3–19). For these reasons, this assessment analyzes project alternative changes to DOC, comparing the relative change in long-term average DOC at each assessment location to the previously discussed significance thresholds, as well comparing the relative change in frequency that 2, 3, and 4 mg/L concentration thresholds are exceeded.

Organic Carbon at Barker Slough

An important Delta assessment location is DWR's North Bay Aqueduct intake at Barker Slough. While source-water fingerprinting identifies the Sacramento River as comprising the majority of flow at the Barker Slough location, the quality of water is substantially influenced by local sources in the Barker Slough catchment. These local sources contribute a significant organic carbon load to the Barker Slough location, where average TOC between 2001 and 2005 was 5.8 mg/L and as high as 20 mg/L in winter months (Archibald Consulting et al. 2007: 3-19, 3-26). The DSM2 model does not account for these local sources and, therefore, concentrations presented in this assessment generally underestimate baseline DOC conditions. Nevertheless, operations and maintenance activities will not substantially affect these local sources to Barker Slough and thus their contribution to annual average DOC would continue to occur regardless of project alternative implementation. The modeling presented in this assessment for the Barker Slough location accounts for expected changes in DOC relative to changes in Delta hydrodynamics, excluding local watershed sources to Barker Slough.

Pathogens

The term "pathogens" refers to viruses, bacteria, and protozoa that pose human health risks. Pathogens of concern include bacteria, such as *Escherichia coli* and *Campylobacter*; viruses such as hepatitis and rotavirus; and protozoans such as *Giardia* and *Cryptosporidium*. Sources of pathogens include natural watershed runoff that contains wastes from wild and domestic animals, aquatic species, urban runoff, discharge from wastewater treatment plants, and agricultural point and nonpoint sources such as confined feeding lots and stormwater runoff. Most data that exist regarding pathogens is for coliform bacteria, which are indicators of potential fecal contamination by humans or other warm-blooded animals, because of there relative abundance and ease of measuring in water samples.

Once in the ambient environment, pathogens often die off, although in some instances they can survive and even reproduce in sediments. In most instances, pathogens in drinking water sources are removed by filtration or membranes or destroyed by disinfection techniques. Infections in humans may arise from pathogens that break through into treated drinking water or from external sources such as food ingestion and ingestion of untreated water during recreation.

The beneficial uses of the surface waters in the affected environment that are affected by the presence of pathogens in the environment are Municipal and Domestic Supply, Water Contact Recreation, Shellfish Harvesting, and Commercial and Sport Fishing. Of these beneficial uses, Municipal and Domestic Supply, Water Contact Recreation, and Shellfish Harvesting are the receptors considered most sensitive to the effects of ambient pathogen levels in surface water bodies.

Applicable pathogens objectives for surface waters the environmental setting/affected environment are summarized in (Table 8-52). Because pathogens are not priority pollutants, there are no criteria established for pathogens in the National Toxics Rule or CTR.

Table 8-52. Applicable Federal Criteria, State Objectives, and other Relevant Effects Thresholds for Pathogens (MPN/100 ml)

Organism	Region 5 Basin Plan	Region 2 Basin Plan	CTR	Drinking Water MCL	U.S. EPA Recommended Criteria[l]	Other Relevant Thresholds
Fecal Coliform	REC-1[a] 200 400 Folsom Lake[b] 100 200	SHELL[c] <14 / <43 MUN[d] <20 REC1[e] <200 / <400 REC2[f] <2,000 / <4,000	--	--	--	--
Total Coliform	--	SHELL[g] <70 / <230 MUN[h] <100 REC1[i]	--	--	--	--

Organism	Region 5 Basin Plan	Region 2 Basin Plan	CTR	Drinking Water MCL	U.S. EPA Recommended Criteria[l]	Other Relevant Thresholds
Enterococcus	--	<240 / <10,000 REC1[j] 35/104	--	--	Freshwater Bathing 33 Marine Water Bathing 35	--
E. coli	REC-1[k] 126/235	--	--	--	Freshwater Bathing 126	--

[a] Objectives apply to waters designated REC-1 (contact recreation); concentration based on not less than five samples for any 30-day period shall not exceed a geometric mean of 200 organisms/100 ml, nor shall more than 10% of the total number of samples taken during any 30-day period exceed 400 organisms/100 ml (Central Valley Regional Water Quality Control Board 2009).

[b] Objectives apply to Folsom Lake; concentration based on not less than five samples in any 30-day period shall not exceed a geometric mean of 100 organisms/100 ml, nor shall more than 10% of the total number of samples taken during any 30-day period exceed 200 organisms/100 ml (Central Valley Regional Water Quality Control Board 2009).

[c] Objectives apply to waters designated SHELL (shellfish harvesting); <14 MPN/100 ml objective is a median and <43 MPN/100 ml is a 90th percentile, both based on a minimum of five consecutive samples equally spaced over a 30-day period (San Francisco Bay Regional Water Quality Control Board 2009).

[d] Objective applies to waters designated MUN (municipal supply); applied as a geometric mean based on a minimum of five consecutive samples equally spaced over a 30-day period (San Francisco Bay Regional Water Quality Control Board 2009).

[e] Objectives apply to waters designated REC1 (contact recreation); <200 MPN/100 ml objective is a geometric mean and <400 MPN/100 ml is a 90th percentile, both based on a minimum of five consecutive samples equally spaced over a 30-day period (San Francisco Bay Regional Water Quality Control Board 2009).

[f] Objectives apply to waters designated REC2 (noncontact recreation); <2000 MPN/100 ml objective is a mean and <4000 MPN/100 ml is a 90th percentile, both based on a minimum of five consecutive samples equally spaced over a 30-day period (San Francisco Bay Regional Water Quality Control Board 2009).

[g] Objectives apply to waters designated SHELL (shellfish harvesting); <70 MPN/100 ml objective is a median and <230 MPN/100 ml is a 90th percentile, both based on a minimum of five consecutive samples equally spaced over a 30-day period (San Francisco Bay Regional Water Quality Control Board 2009).

[h] Objective applies to waters designated MUN (municipal supply); applied as a geometric mean based on a minimum of five consecutive samples equally spaced over a 30-day period.

[i] Objectives apply to waters designated REC1 (contact recreation); <240 MPN/100 ml objective is a geometric mean and <10,000 MPN/100 ml is a 90th percentile, both based on a minimum of five consecutive samples equally spaced over a 30-day period (San Francisco Bay Regional Water Quality Control Board 2009).

[j] This is a Region 2 Basin Plan amendment approved by the San Francisco Bay Regional Water Board. Objectives apply to waters designated REC1 (contact recreation); <35 MPN/ 100 ml objective is a geometric mean based on a minimum of five consecutive samples equally spaced over a 30-day period and no sample may greater than 104 MPN/100 ml. Applicable to marine and estuarine waters only. (San Francisco Bay Regional Water Quality Control Board 2010a, 2010b) This amendment is pending approval by the State Water Board, Office of Administrative Law, and USEPA.

[k] This is a Region 5 Basin Plan amendment approved by the Central Valley Regional Water Quality Control Board that deletes the current general objective for fecal coliform and replaces it with an objective for E. coli, requiring that not less than five samples equally spaced over a 30-day period shall not exceed a geometric mean of 126 organisms/100 ml and shall not exceed 235 organisms/100 ml in any single sample (Central Valley Regional Water Quality Control Board 2002). This amendment is pending approval by the State Water Board, Office of Administrative Law, and USEPA.

[l] USEPA's Gold Book Criteria. Geometric mean based on generally not less than five samples equally spaced over a 30-day period (U.S. Environmental Protection Agency 1986).

The Stockton Deep Water Ship Channel and various sloughs and creeks in the western and eastern Delta are listed on the state's Clean Water Act section 303(d) list as impaired due to pathogens, with sources identified as recreational and tourism activities [nonboating] and urban runoff/storm sewers (State Water Board 2011). A TMDL for the Stockton Urban Waterbodies was approved by U.S. EPA on 13 May 2008. TMDLs for other listed water bodies in the affected environment are proposed for completion in 2021(State Water Board 2011).

Pesticides

A pesticide is any substance or mixture of substances intended for preventing, destroying, repelling, or mitigating any pest. Pesticides typically occur in the form of chemicals or biological agents (e.g., virus or bacterium) and are often formulated for specific pests such as weeds (herbicides), insects (insecticides), and fungi (fungicides) among others. A major concern with pesticides is that they may harm non-target aquatic organisms (e.g., fish, their food organisms, shellfish) at elevated concentrations. While individuals may display negative short-term acute symptoms, populations may be negatively impacted by long-term chronic effects. Municipal and domestic drinking water supplies may also be negatively impacted by elevated pesticide quantities in the aquatic environment.

Regions on the CWA section 303(d) list for pesticides include the Central Valley Region (chlordane, chlorpyrifos, DDT, diazinon, dieldrin, and Group A pesticides) and the San Francisco Bay Region (chlordane, DDT, dieldrin). There are many waterbodies served by SWP South-of-Delta exports listed for pesticide impairment (State Water Resources Control Bard 2007) including the Central Coast Regional Water Board (69 listed), the Los Angeles Regional Water Board (177 listed), the Santa Ana Regional Water Board (16 listed), and the San Diego Regional Water Board (18 listed). Chlorpyrifos and diazinon TMDL studies have been completed for Sacramento County urban creeks, the Feather River, the Sacramento River, the San Joaquin River, and the Delta; ongoing TMDL studies are occurring for organochlorine and other pesticides.

Pesticides, including pyrethroid, organophosphate (OP), and carbamate insecticides, herbicides, and fungicides are used extensively throughout the Central Valley. Assessing pesticide related effects is substantially challenged by: 1) limited available monitoring data in the Delta and other water bodies of the affected environment, and 2) a continually changing pesticide use market. Due to a number of factors, including historic pesticide use patterns and analytical capabilities, there is more data available for certain classes of pesticides, such as OP insecticides, than that for other classes of pesticides, including herbicides, fungicides, and insecticides such as pyrethroids and carbamates.

Likely the single most recent and comprehensive compilation of pesticide data for the Delta and upstream water bodies (within 30 miles of the Delta) was compiled by Johnson et al. (2010). The result of this compilation and review was the conclusion that there were few chemicals for which data were of sufficient number and quality to allow a definitive conclusion regarding contaminants and toxicological issues in the Delta such as the pelagic organism decline (POD). The stated exception was that of the OP insecticides chlorpyrifos and diazinon, where frequent toxicity to bioassay indicator organisms has been associated with measurable concentrations of chlorpyrifos and diazinon (Kuivilla and Foe, 1995, Werner et al., 2000). In fact, in the comprehensive review of Johnson et al. (2010), only the analysis of diazinon, chlorpyrfos, several pyrethroid insecticides and the herbicide diuron were carried forward, primarily due to data quantity and quality limitation. In this compilation, cumulative frequency distributions were prepared, suggesting that less than 10% of all samples for chlorpyrifos, diazinon, and diuron would be expected to exceed benchmark toxicity thresholds. Data for the pyrethroid insecticides were too limited, primarily due to data quality issues (i.e., insufficiently low detection limits). However, pyrethroid-related research and regulatory interest has intensified with the fairly recent observation of substantial pyrethroid associated toxicity in sediments and the water column of numerous urban streams, agricultural drainage canals, and municipal wastewater effluent (Weston and Lydy, 2010). These pyrethroid observations are largely believed to be related to their recent increased use as a suitable substitute for diazinon and chlorpyrifos.

Perhaps more challenging than a limited monitoring effort is the dynamic state of the pesticide market. Regulatory and pest resistance pressures have left the pesticide market, namely the insecticide market, in a state of flux. Normal pesticide use varies from year to year depending on numerous external factors such as climate and associated pest outbreaks, cropping patterns, and economic trends in housing construction and urban development. Layered upon this year-to-year variation is an overall trend of decreased OP insecticides use and increased pyrethroid use, primarily due to the early regulatory phase-out of many OP insecticide uses initiated in early 2000. The market has yet to balance and reach equilibrium, and what limited and relatively short-term monitoring data that is available ultimately only represents a snapshot of a trend in the gradual replacement of many OP uses with that of pyrethroids. Until markets stabilize, trends will inevitably continue to develop.

For rivers, a number of factors are necessaryfor pesticide-related impacts on beneficial uses to be a possibility. Although a number of relevant beneficial uses exist, for the majority of pesticides aquatic life beneficial uses are the greatest concern. For concentrations of pesticides in surface water to reach thresholds of aquatic life concern, a number of controlling factors are typically at play. First and foremost, pesticides must be used, and used in a location with hydrologic connectivity to surface water, and used in amounts that aren't easily diluted in the environment. Secondly, the pesticide must be transportable. The ultimate transportability of a pesticide is largely determined by its individual chemistry, where its chemistry determines important properties such as water solubility, vaporization, and soil sorption. Factors unrelated to the pesticide are also important, such as substrate erosivity, precipitation or irrigation amounts, and time elapsed from application to runoff. Thirdly, the pesticide must be stable in the environment, such that residues of the applied pesticide are present during runoff events. And finally, if transported to surface waters, sufficient amounts of pesticide must be present that once diluted by surface water flows, the resulting concentration is of a magnitude capable of eliciting a measurable effect in aquatic life. All of these factors contribute in the end to the potential for adverse beneficial use effects, but of the many factors involved, CVP/SWP operations only affect river flows and, thus available dilution. In an estuary environment, where substantial dilution capacity typically occurs, duration of aquatic life exposure in addition to pesticide concentration is important. While the capacity of the Delta to dilute pesticide inputs is largely unaffected by CVP/SWP operations, the duration of exposure, or residence time, can be affected by operations. Therefore, in the Delta, changes in source water fractions represent long-term changes in exposure potential.

Similar to the assessment of Johnson et al. (2010), there is insufficient data to perform an assessment of BDCP alternatives' effects on all pesticides. Within available data, however, there is sufficient evidence that the OP insecticides diazinon and chlorpyrifos, and the herbicide diuron may be found in the affected environment at concentrations frequently toxic to aquatic life, and to such a degree that changes in CVP/SWP operations could possibly have an effect. Furthermore, although pyrethroid insecticides have not been demonstrated to have the same magnitude of concern, trends in OP replacement and increased pyrethroid use suggest that, while possibly not a great concern today, pyrethroids may become an increasing concern in the future. Therefore, this assessment focuses on potential effects of CVP/SWP operations into the future, under the various considered alternatives, on diazinon, chlorpyrifos, pyrethroids, and diuron, and the possibility that the frequency or magnitude of existing pesticide related risk to beneficial uses might change.

This assessment utilizes recent research and monitoring related to OP, diuron and pyrethroid incidence in ambient waters to qualitatively assess the effects of the alternatives on those pesticides and their possible related aquatic harm. Effects of alternatives on pesticides are primarily incidental and indirect, as existing and future sources of pesticide loading are largely unrelated. Further, effects on pesticides would be related to the change in river flow rates and Delta source water volumes. Because these changes would not directly affect pesticide source loading, but could affect in-stream pesticide concentrations through dilution as well in-water pesticide dispersion and geographic distribution, changes in CVP/SWP operations could alter the long-term risk of pesticide-related effects on aquatic life beneficial uses. This change in risk can be qualitatively assessed through change in river flows and associated dilution, as well as change in source water fraction and associated opportunity for exposure. Pesticide effect assessments based on dilution flows and source water fraction is heavily burdened by assumptions regarding pesticide use into the future. As well, pesticide effects assessments based on changes in potential risk are heavily burdened by presumptions of real hazard relative to actual in-stream concentrations and actual effect thresholds which cannot be determined. It is assumed that sources of pesticides to water bodies would be similar for all alternatives.

Legacy Pesticides

In addition to the present-use pesticides described above, "legacy" pesticides, which have been banned for decades and include numerous organochlorine (OC) insecticides including DDT, can still be found in terrestrial soils and riverine sediments throughout the Central Valley. Residues of these OC pesticides enter rivers primarily through surface runoff and erosion of terrestrial soils during storm events, and through resuspension of riverine bottom sediments, the combination of which to this day may contribute to excursions above water quality objectives (Central Valley Regional Water Quality Control Board, 2010). Operation of the CVP/SWP does not affect terrestrial sources, but may result in geomorphic changes to the affected environment that ultimately could result in changes to sediment suspension and deposition. However, as discussed in greater detail for Turbidity/TSS (Section 8.### - cross reference to Turbidity and TSS), operations under any alternative would not be expected to change TSS or turbidity levels (highs, lows, typical conditions) to any substantial degree. Changes in the magnitude, frequency, and geographic distribution of legacy pesticides in water bodies of the affected environment that would result in new or more severe adverse effects on aquatic life or other beneficial uses, relative to existing conditions or the No Action Alternative, would not be expected to occur. Therefore, the remainder of this assessment focuses on the present use pesticides for which substantial information is available, namely diazinon, chlorpyrifos, pyrethroids, and diuron.

Phosphorus

Sources of phosphorus to surface waters include municipal discharges, and agricultural and urban runoff. In the aquatic environment phosphorus may rapidly cycle between water, organisms, and sediments. Overall, phosphorus concentrations in the San Joaquin River and the Delta are relatively high. Dissolved orthophosphate is the form that is generally considered to be available for algal and plant uptake. Total phosphorus may be a better determinant of lake and reservoir productivity, because most phosphorus is tied up in plankton and organic particles during periods of high productivity. Therefore, dissolved orthophosphate concentrations may be very low in highly productive lakes and reservoirs (Tetra Tech 2006:2-4). The dynamics and speciation of phosphorus in flowing water bodies such as the Sacramento and San Joaquin rivers is not as straightforward, because they continually receive phosphorus from upstream, groundwater, and runoff. Because of this, the form that phosphorus is delivered in plays a role in determining which form of phosphorus is a better predictor of productivity downstream (Tetra Tech 2006:2-5). An analysis of source waters to the Delta found that orthophosphate may make up from very little to almost all of the total phosphorus at a location at any given time (Tetra Tech 2006:3-25 to 3-26).

As discussed in the nitrate section of this chapter, aquatic life depends on the availability of nutrients; however, elevated concentrations of nutrients such as phosphorus can cause eutrophication, in which high algal and bacterial growth and subsequent microbial respiration deplete oxygen, producing anoxic waters and sediments. Waters of the Delta are not considered nutrient limited; that is, algal growth rates are limited by availability of light, and thus increases or decreases in nutrient levels are, in general, expected to have little effect on productivity (Jassby et al. 2002). However, when waters of the Delta are exported into conveyance canals, algae may no longer be light-limited, and thus increases in nutrient levels in Delta export waters may increase phytoplankton growth within the canals. Algal blooms are problematic in that they create biomass that can obstruct water conveyance facilities and clog filters, and they may also lead to taste and odor problems for municipal supplies (Sanitary Survey:3-69).

However, regarding the potential for taste and odor concerns, Lee (2008) summarized a presentation by P. Hutton (Metropolitan Water District), given at the March 25, 2008, California Water and Environmental Modeling Forum (CWEMF) "Delta Nutrient Water Quality Modeling Workshop", that stated: "there is limited ability to relate nutrient loads or in-channel concentrations to domestic water supply water quality. While there is some ability to model the relationship between the nutrient load to a waterbody and the planktonic algal biomass that develops in the waterbody, it is not possible to adequately model the relationship between nutrient load to a waterbody and the development of benthic and attached algae in that waterbody" (Lee 2008:6). This is important in that benthic and attached algae are potentially more important for taste and odor concerns than is planktonic biomass generally (Juttner and Watson, 2007:1-2).

The beneficial uses most directly affected by phosphorus concentrations include aquatic organisms (cold freshwater habitat, warm freshwater habitat, and estuarine habitat), drinking water supplies (municipal and domestic supply), and recreational activities (water contact recreation, non-contact water recreation), which can be indirectly affected by the nuisance eutrophication effects of nutrients.

There are presently no state or federal objectives/criteria for phosphorus. An analysis of nutrient loads to the Delta found that phosphorus concentrations showed little inter-seasonal variability between the Sacramento and San Joaquin Rivers (Tetra Tech 2006b). Data gathered for this assessment confirm this finding, and also show that little variability exists between these two rivers and between San Francisco Bay water at Martinez. Current estimates for in-Delta contribution of nutrients from agriculture on the Delta islands are small compared to tributary sources (Tetra Tech 2006b). Table XZ summarizes dissolved orthophosphate data for source waters to the Delta, and Figure 60 shows the seasonal variation in dissolved orthophosphate concentrations among the three major source waters. During April through December, orthophosphate concentrations from the three major source waters are very similar. During January through March, concentrations in the

San Joaquin River at Vernalis are noticeably greater than from the Sacramento River at Hood/Greene's Landing or San Francisco Bay at Martinez.

Table XZ. Summary of Dissolved Orthophosphate Concentrations (mg/L-P) in Delta Source Waters

Source Water	Sacramento River	San Joaquin River	San Francisco Bay	East Side Tributaries
Mean (mg/L as P)	0.068	0.106	0.092	0.018
Minimum (mg/L as P)	0.010	0.010	0.030	0.010
Maximum (mg/L as P)	0.24	0.45	0.18	0.090
75th Percentile (mg/L as P)	0.090	0.130	0.11	0.020
99th Percentile (mg/L as P)	0.18	0.28	0.17	0.06
Data Source	DWR, BDAT	DWR, BDAT	BDAT	USGS
Station(s)	Sac River at Greene's Landing (BDAT only), Sac River at Hood	SJR at Vernalis	Suisun Bay at Bulls Head near Martinez	Mokelumne River
Date Range	1975 - 2009	1975 - 2009	1975 - 2006	1977 - 1994
ND Replaced with RL	No	No	No	Yes
Data Omitted	None	None	None	Single value reported as "0"
No. of Data Points	523	502	203	100

Selenium

[*Note to Lead Agencies: Discussion in preparation.*]

Trace Metals

Trace metals, such as arsenic, cadmium, chromium, copper, iron, lead, manganese, nickel, silver, and zinc occur naturally in the environment. Due to unique environmental concerns, mercury and selenium are assessed individually, despite also being trace metals. Many trace metals are necessary for healthy biological function, where deficiencies in certain trace metals can result in disease and ailment. At elevated levels, trace metals can be toxic to humans and aquatic life, where the concentration of concern in surface waters is specific to each metal and each receptor (i.e., human or aquatic life). Sources of these metals include natural crustal material such as soils, as well enriched ore deposits. Due to their industrial and commercial utility, trace metals can also be found in urban and agricultural stormwater runoff, landfill and mine leachate, as well industrial and municipal wastewater discharges.

Clean Water Act Section 303(d) listings in the affected environment include: cadmium, copper, and zinc in Lake Shasta, Keswick Reservoir, and the Sacramento River for 15 miles downstream of Keswick Dam; copper, lead, nickel, zinc, and metals generally in San Francisco Bay or its surrounding wetlands and marsh areas; many listings in the Central Coast, Los Angeles, Santa Ana, and San Diego Regions which include the SWP and CVP Export Service Area. There are no 303(d) listings or TMDLs for trace metals in the Delta.

Arsenic, cadmium chromium, copper lead, nickel, silver and zinc are among the 126 "priority pollutants" identified by the USEPA. Iron, and manganese are identified as "non-priority" pollutants by USEPA. Federal water quality criteria contained in the CTR, state water quality objectives contained in the Region 2 and Region 5 Water Quality Control Plans, and drinking water maximum contaminant levels (MCLs) are shown in Table M1. Based on water quality criteria and objectives, it is generally the case that arsenic, iron, and manganese are of primary concern for drinking water, while cadmium, chromium, copper, lead, nickel, silver, and zinc are of concern (at typical concentrations in surface waters) due to potential toxicity to aquatic organisms.

The CTR contains criteria for protection of freshwater aquatic life, saltwater aquatic life, and human health from consumption of water (drinking water) and organisms (eating fish and shellfish) and organisms only. For waters in which the salinity is equal to or less than 1 part per thousand 95% or more of the time, the applicable CTR criteria are the freshwater criteria. For waters in which the salinity is equal to or greater than 10 parts per thousand 95% or more of the time, the applicable CTR criteria are the saltwater criteria. For waters in which the salinity is between 1 and 10 parts per thousand, the applicable CTR criteria are the more stringent of the freshwater or saltwater criteria.

The CTR criteria for cadmium, chromium (III), copper, lead, nickel, silver, and zinc are promulgated as equations that contain three adjustments: 1) the water-effect ratio (WER), 2) the conversion factor (CF) from total to dissolved fraction, and 3) hardness (freshwater criteria only), which are used to adjust the criteria based on site-specific water quality conditions in order to provide the level of protection intended by U.S. EPA. Table M2 presents hardness adjusted CTR criteria for the primary Delta source waters, including the Sacramento and San Joaquin Rivers. Criteria were calculated based on each source waters average and 5th percentile hardness (See Appendix 8N for hardness data). Due to lower average and 5th percentile hardness on the Sacramento River, calculated hardness-based metals aquatic life criteria are lowest on the Sacramento River.

The quality of water representative of the Bay source water fraction is highly seasonal, with conditions ranging between freshwater and saltwater conditions. In such a case, CTR metals criteria guidance states that the more stringent of the freshwater of saltwater criteria is to be used. Comparing saltwater criteria listed in Table M1 to freshwater criteria in Table M2, saltwater criteria for copper and nickel are more stringent than the corresponding hardness-based freshwater criteria.

Table M1. Water Quality Criteria and Objectives for Trace Metals (µg/L)

	Freshwater		Saltwater		Human Health			
Metal	Acute[1]	Chronic[1]	Acute[1]	Chronic[1]	Water & Organisms	Organisms Only	Region 5 Basin Plan	California Drinking Water MCLs[5]
Arsenic	340	150	69	36	n/a	n/a	10[2]	10
Cadmium	4.3/3.9[3]	2.2/1.1[3]	42	9.3	n/a	n/a	0.22[4]	5
Chromium (III)	550	180	n/a	n/a	n/a	n/a	n/a	50
Copper	13	9	4.8	3.1	1,300	n/a	5.6[4]/10[2]	1,000
Iron	n/a	1,000[6]	n/a	n/a	n/a	n/a	300[2]	300
Lead	65	2.5	210	8.1	n/a	n/a	n/a	15
Manganese	n/a	n/a	n/a	n/a	n/a	n/a	50[2]	50
Nickel	470	52	74	8.2	610	4,600	n/a	100
Silver	3.4	n/a	1.9	n/a	n/a	n/a	10[2]	100
Zinc	120	120	90	81	n/a	n/a	100[2]/16[4]	5,000

All values in micrograms per liter (ug/L) and expressed as dissolved metal, unless otherwise noted.
n/a = non-applicable.

1 Values represent both CTR/NTR criteria and criteria contained within the Region 2 Basin Plan. Acute values are applicable to short periods of time, generally defined as 1-hour average concentrations. Chronic values are defined as 4-day average concentrations. For metals whose CTR criteria allow for adjustments based on WER, CF, and hardness, values in the table assume a default WER of 1.0, default CFs contained within the CTR, and a default hardness of 100 mg/L (as $CaCO_3$).

2 Applies at the following locations: Sacramento River from Keswick Dam to the I Street Bridge at City of Sacramento; American River from Folsom Dam to the Sacramento River; Folsom Lake; and the Sacramento-San Joaquin Delta.

3 First value is the CTR cadmium criterion, second value is Region 2 Basin Plan criterion.

4 Applies to the Sacramento River and its tributaries above State Hwy 32 bridge at Hamilton City.

5 Expressed as total recoverable metal.

6 EPA 304(a) national recommended criteria.

Table M2. Hardness-based aquatic life criteria by primary source water (µg/L)

Metal	Sacramento 5th Percentile Hardness Dissolved, Freshwater		Sacramento Average Hardness Dissolved, Dissolved Freshwater	
	Acute	Chronic	Acute	Chronic
Cadmium	0.81	0.128	1.19	0.168
Copper	5.53	4.006	8.04	5.623
Chromium (III)	263.50	34.276	364.71	47.441
Lead	22.86	0.891	35.52	1.384
Nickel	211.11	23.448	295.34	32.803
Silver	0.64	--	1.26	--
Zinc	52.77	53.199	73.86	74.464
Metal	San Joaquin 5th Percentile Hardness Dissolved, Freshwater		San Joaquin Average Hardness Dissolved, Dissolved Freshwater	
	Acute	Chronic	Acute	Chronic
Cadmium	1.13	0.162	2.93	0.321
Copper	7.65	5.373	19.32	12.447
Chromium (III)	349.18	45.421	781.14	101.610
Lead	33.49	1.305	97.98	3.818
Nickel	282.37	31.362	648.66	72.046
Silver	1.15	-	6.24	--
Zinc	70.61	71.187	162.41	163.742
Metal	Bay 5th Percentile Hardness Dissolved, Freshwater		Bay Average Hardness Dissolved, Dissolved Freshwater	
	Acute	Chronic	Acute	Chronic
Cadmium	1.11	0.160	13.98	0.981
Copper	7.52	5.290	88.25	49.357
Chromium (III)	343.97	44.744	2925.17	380.504
Lead	32.82	1.279	518.97	20.224
Nickel	278.02	30.879	2537.13	281.796
Silver	1.11	--	99.88	--
Zinc	69.52	70.089	636.59	641.798

Metals differ in their physical and chemical parameters and thus in their fate, transport, and bioavailability in the aquatic environments. Throughout this assessment dissolved metals concentrations are utilized, because the dissolved fraction better approximates the bioavailable fraction to aquatic organisms. Furthermore, drinking water treatment plants readily remove particulate and suspended mater from raw water. While maximum contaminant levels for treated drinking water are measured on a total recoverable basis, the dissolved fraction of these metals is taken as the more accurate predictor of metals concentration post-treatment. This is particularly the case with iron and manganese which are both naturally abundant in soil. Total recoverable iron and manganese concentrations can be very high in water carrying a substantial load of suspended matter (i.e., TSS). Therefore, assessment of aquatic life and drinking water effects utilizes the dissolved fraction of trace metals in the environment.

Research has shown that elevated copper levels in water bodies are of concern for disruption of olfactory cues in salmonids when migrating to their natal streams to spawn, which can lead to increased straying. However, the U.S. EPA-developed biotic-ligand-model (BLM) based copper criteria have been shown to always be protective of these concerns (Meyer and Adams, 2010: 2096). Because of this, BLM-based copper criteria were derived for the Sacramento and San Joaquin Rivers, as shown in Table M3. The BLM criteria account for the aggregate effect of several different water quality parameters on copper toxicity in addition to hardness (e.g., dissolved organic carbon, pH, and various salt concentrations), with the protective criterion being sensitive to dissolved organic carbon (DOC) concentrations in water. When calculated based on the average of all necessary parameters and the 5th percentile DOC, copper BLM-based criteria were higher (i.e., less sensitive) than the corresponding non WER-adjusted copper criteria presented in Table M2. Therefore, the calculated hardness-based copper criteria are found to be adequately protective of fish olfaction.

Table M3. BLM-based criteria for dissolved copper (µg/L)

SACRAMENTO	CMC	CCC
Average of all BLM parameters	10.9299	6.7888
5th Percentile DOC; Average of remaining parameter	6.9774	4.3338

SAN JOAQUIN	CMC	CCC
Average of all BLM parameters	15.9659	9.9167
5th Percentile DOC; Average of remaining parameter	10.0879	6.2658

There is currently no single program or effort for the coordinated and comprehensive measurement of trace metals in the Delta and its primary source waters. Moreover, analytical techniques for trace metals measurement have improved considerably over time, often resulting in substantially lower detection limits and at time showing earlier techniques to be prone to analytical error. Nevertheless, local monitoring efforts such as the San Francisco Bay Regional Monitoring Program (RMP) and the Sacramento Coordinated Regional Monitoring Program have collected trace metals on the Sacramento River and the San Francisco Bay for more than a decade, resulting in an adequate long-term characterization of these waters. Unfortunately, there has been no equivalent effort on the San Joaquin River, east-side tributaries, or within the Delta itself. This imbalance in available data limits the effects assessment approach. Effects are qualitatively assessed.

Summaries of trace metals data compiled for this qualitative assessment are provided in Appendix 8N. Data of sufficient quality were available for the Bay, Sacramento River and San Joaquin River source waters, although data for the San Joaquin are very few These data used to inform the qualitative assessment on trace metal effects upstream of the Delta, within the Delta, and the SWP and CVP service areas. Due to the relatively short exposure durations related to aquatic life acute and chronic effects, long-term trace metals effects are evaluated on a 95th percentile concentration basis. Due to the relatively long exposure durations related to drinking water effects, long-term trace metals effects are evaluated on an average concentration basis.

Total Suspended Solids and Turbidity

Total suspended solids (TSS) is a measure of the particulate matter that is suspended in the water column, consisting of organic materials (e.g., decaying vegetation) as well as inorganic materials (e.g., inorganic components of soil). Turbidity is a measure of the optical property of water that causes light to be scattered and absorbed rather than transmitted through the water column. The scattering and absorption of light is caused by: (1) water itself; (2) suspended particulate matter (colloidal to coarse dispersions); and, (3) dissolved chemicals.

Sensitive receptors that have the potential to be affected by elevated TSS concentrations and turbidity levels are municipal and industrial water supply uses (Municipal and Domestic Supply/Industrial Service Supply), and some aquatic life beneficial uses (i.e., Warm Freshwater Habitat, Cold Freshwater Habitat, Migration of Aquatic Organisms, Spawning, Reproduction and/or Early Development). In the Delta, a declining turbidity trend, which has been attributed to a declining sediment supply, is believed to have caused, at least in part, changes in Delta ecology and the decline of delta smelt (Hestir et al. 2010).

Stormwater runoff and overland flow are the likely mechanisms delivering sediment from agricultural and urbanized areas to streams and larger rivers, though erosion control practices may be implemented to minimize this contribution (Schollhamer et al. 2007). Floodplain management in the form of levees can contribute to in-stream erosion by confining the flow to the channel and increasing streambed shear stress, however, channels for flood management are often lined to protect the channel and minimize erosion (Schollhamer et al. 2007).

Applicable TSS and turbidity objectives for the affected environment are summarized in Table 8-53. There are no numeric criteria for TSS. Because TSS and turbidity are not priority pollutants, there are no criteria established for these parameters in the National Toxics Rule or CTR.

None of the water bodies in the affected environment have been listed as impaired on the state's Clean Water Act section 303(d) list due to elevated TSS or turbidity (State Water Resources Control Board 2011).

Table 8-53. Applicable Federal Criteria, State Objectives, and other Relevant Effects Thresholds for Total Suspended Solids and Turbidity (in NTU) ***

	Region 5 Basin Plan	Region 2 Basin Plan	CTR/NTR	Drinking Water MCL	U.S. EPA Recommended Criteria	Other Relevant Thresholds
Total Suspended Solids (TSS)	Narrative[a]	Narrative[a]	--	--	Narrative[d]	--
Turbidity	General[b] Central Delta 50 Other Delta Waters 150	General <10% increase where natural turbidity is 50 MUN 5	--	5[3]	--	50[e]

[a] The suspended sediment load and suspended sediment discharge rate of surface waters shall not be altered in a manner as to cause nuisance or adversely affect beneficial uses (Central Valley Regional Water Quality Control Board 2009, San Francisco Bay Regional Water Quality Control Board 2007).

[b] Increases in turbidity attributable to controllable water quality factors shall not exceed the following limits:

Where natural turbidity is less than 1 Nephelometric Turbidity Unit (NTU), controllable factors shall not cause downstream turbidity to exceed 2 NTU;

Where natural turbidity is between 1 and 5 NTUs, increases shall not exceed 1 NTU.

Where natural turbidity is between 5 and 50 NTUs, increases shall not exceed 20%.

Where natural turbidity is between 50 and 100 NTUs, increases shall not exceed 10 NTUs.

Where natural turbidity is greater than 100 NTUs, increases shall not exceed 10%.

[c] California Department of Public Health secondary maximum contaminant level (MCL), California Code of Regulations, Title 22, Table 64449-A.

[d] USEPA Gold Book Criteria: for protection of freshwater fish and aquatic life, settleable and suspended solids should not reduce the depth of the compensation point for photosynthetic activity by more than 10% from the seasonally established norm for aquatic life (USEPA 1986).

[e] CALFED turbidity goal at drinking water intakes in the Delta (CALFED Bay-Delta Program 2007).

8.3.4 Effects and Mitigation Approaches

8.3.4.1 No Action Alternative

Impact WQ-1: Effects on ammonia concentrations resulting from facilities operations and maintenance (CM1)

Upstream of the Delta

Substantial point sources of ammonia-N do not exist upstream of the SRWTP in the Sacramento River watershed, in the watersheds of the eastern tributaries (Cosumnes, Mokelumne, and Calaveras Rivers), or upstream of the Delta in the San Joaquin River watershed. Nonpoint sources of ammonia-N within the watersheds are also relatively low, thus resulting in generally low ammonia-N concentrations in the reservoirs and rivers of the watersheds. Consequently, any modified reservoir operations and subsequent changes in river flows under the No Action Alternative LLT, relative to existing conditions and the No Action Alternative NT, are expected to have negligible, if any, effects on reservoir and river ammonia-N concentrations upstream of Freeport in the Sacramento River watershed and upstream of the Delta in the San Joaquin River watershed. Any negligible changes in ammonia-N concentrations that may occur in the water bodies of the affected environment located upstream of the Delta would not be of frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the quality of these water bodies, with regards to ammonia.

Delta

As summarized in Table 8-44, under the No Action Alternative LLT, it is assumed that SRWTP upgrades would be in place, and thus that the average monthly effluent ammonia concentration would not exceed 1.8 mg/L-N. In comparison, the permitted average monthly effluent ammonia concentration under the existing conditions and the No Action Alternative NT is 33 mg/L-N, with actual monthly average ammonia concentration in the effluent being approximately 24 mg/L-N (Central Vallley Regional Water Quality Control Board 2010 Aquatic Issue Paper:10). Because of this, ammonia concentrations in the Sacramento River downstream of the SRWTP would be substantially lower under the No Action Alternative LLT, relative to existing conditions and the No Action Alternative NT. As shown in Figure 59, Sacramento River ammonia concentrations currently are of the same magnitude as San Joaquin River and San Francisco Bay concentrations of ammonia during the January through March period of the year, and much greater than these two sources for the remainder of the year. Consequently, a substantial decrease in Sacramento River ammonia concentrations is expected to decrease ammonia concentrations for all areas of the Delta that are influenced by Sacramento River water. Additionally, San Joaquin River and San Francisco Bay concentrations are similar to each other throughout the year (Figure 59), indicating that any change in source water fraction from BAY to SJR or from SJR to BAY at locations in the Delta would not substantially alter concentrations at these locations. Therefore, at locations which are not influenced notably by Sacramento River water, concentrations are expected to remain relatively unchanged. Any negligible increases in ammonia-N concentrations that may occur at certain locations in the Delta would not be of frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the water quality at these locations, with regards to ammonia.

SWP/CVP Export Service Areas

The assessment of effects on ammonia in the SWP/CVP Export Service Areas is based on assessment of ammonia-N concentrations at Banks and Jones pumping plants. The dominant source waters influencing the Banks and Jones pumping plants are the Sacramento and San Joaquin Rivers (see Appendix C). As discussed above for the Plan Area, for areas of the Delta that are influenced by Sacramento River water, including Banks and Jones pumping plants, ammonia concentrations are expected to decrease under the No Action Alternative LLT, relative to existing conditions and the No Action Alternative NT. This decrease in ammonia-N concentrations for water exported via the south Delta pumps is not expected to result in an adverse effects on beneficial uses or substantially degrade water quality of exported water, with regards to ammonia.

***CEQA Conclusion*:** There would be no substantial, long-term increase in ammonia-N concentrations in the rivers and reservoirs upstream of the Delta, in the Plan Area, or the waters exported to the SWP/CVP Export Service Areas under the No Action Alternative LLT relative to existing conditions. As such, this alternative is not expected to cause additional exceedance of applicable water quality objectives/criteria by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. Because ammonia concentrations would not be expected to increase substantially, no long-term water quality degradation is expected to occur and, thus, no adverse effects on beneficial uses would occur. Ammonia is not 303(d) listed within the affected environment and thus any minor increases than may occur in some areas would not make any existing ammonia-related impairment measurably worse because no such impairments currently exist. Because ammonia-N is not bioaccumulative, minor increases that may occur in some areas would not bioaccumulate to greater levels in aquatic organisms that would, in turn, pose substantial health risks to fish, wildlife, or humans. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-3: Effects on boron concentrations resulting from existing facilities operations and maintenance

Upstream of the Delta

Under the No Action Alternative LLT, greater water demands and climate change would alter the magnitude and timing of reservoir releases and river flows upstream of the Delta in the Sacramento River watershed and east-side tributaries, relative to existing conditions and No Action Alternative NT. Because substantial sources of boron do not exist upstream of the Delta in the watersheds of the Sacramento River and eastside tributaries, concentrations of boron in surface water are low and often below detection limits (see Table Bo-2 and "Affected Environment-Environmental Setting" section). Consequently, changes in the magnitude and timing of reservoir releases and river flows upstream of the Delta would have negligible, if any, effect on boron sources, and ultimately the concentration of boron in the Sacramento River, the east-side tributaries, and the various reservoirs of the related watersheds. Consequently, the No Action Alternative LLT would not be expected to cause exceedance of boron objectives or substantially degrade water quality with respect to boron and thus, would not adversely affect any beneficial uses of the Sacramento River, the east-side tributaries, or their associated reservoirs upstream of the Delta.

South of the Delta, the San Joaquin River is a substantial source of boron. While tributaries and associated reservoirs of the lower San Joaquin are likely negligible sources of boron, loading in the lower San Joaquin watershed contributes to relatively high concentrations which can be sourced to agricultural irrigation of soils containing boron and use of water imported from the south Delta. Average boron concentrations in the lower San Joaquin River at Vernalis are inversely correlated to net river flow and the dilution provided by this flow. Under the No Action Alternative LLT, long-term average flows at Vernalis would decrease 6% relative to existing conditions and 5% relative to No Action NT (Appendix 5A). Based on best-fit regressions of San Joaquin River flow and boron, these decreases in flow would correspond to a potential increase in long-term average boron of about 2% relative to existing conditions and the No Action Alterative NT. The relatively small increase would not cause boron concentrations to exceed applicable objectives relative to existing concentrations or the No Action Alternative NT conditions and would not cause substantial long-term water quality degradation with regards to boron. With respect to the 303(d) listing of the lower San Joaquin River impairment for boron, the increased boron concentrations would not be expected to adversely affect necessary TMDL actions implemented to reduce boron loading in the lower San Joaquin River or make the existing impairment discernibly worse. Consequently, the small increases in lower San Joaquin River boron levels that may occur under the No Action Alternative LLT, relative to existing conditions and the No Action Alternative NT, would not be expected to adversely affect any beneficial uses of the lower San Joaquin River.

Delta

Relative to existing conditions, the No Action Alternative LLT would result in generally similar long-term annual average boron concentrations, or decreased average concentrations, at ten of the eleven Delta assessment locations for the 16-year period modeled (i.e., 1976-1991), and would increase only at the Jones Pumping Plant location by about 3% (Appendix 8F, Table Bo-2). Increased monthly average concentrations would occur at nine of the assessment locations during the months of December through June, with decreased or similar concentrations occurring only at two interior Delta locations (i.e., SF Mokelumne River at Staten Island and San Joaquin River at Buckley Cove). Relative to the No Action Alternative NT, annual average boron concentrations under the No Action

Alternative LLT would increase by similar magnitude (i.e., up to 4%), but at more Delta assessment locations (i.e., Old River at Rock Slough, Sacramento River at Emmaton, Contra Costa Canal at Pumping Plant #1, and the Banks and Jones pumping plant locations). For the drought year period modeled (i.e., 1987-1991), the No Action Alternative LLT would result in increased annual average concentrations at six locations (up to a maximum 4% increase at the Jones Pumping Plant) relative to both existing conditions and the No Action Alternative NT conditions.

With respect to the 2,000 µg/L EPA drinking water human health advisory objective (i.e., for children), the long-term annual average and monthly average boron concentrations, for either the 16-year period or drought period modeled, are low and would never exceed this objective at any of the eleven Delta assessment locations under the No Action Alternative LLT (i.e., maximum long-term average concentration of about 438 µg/L at the Sacramento River at Mallard Island), which represents no change from the existing conditions and No Action Alternative NT conditions (Appendix 8F, Table Bo-3). Moreover, the minor increased long-term average boron concentrations predicted to occur at some Delta assessment locations would not result in measureable long-term use of assimilative capacity (i.e., less than 3% reduction) or further degradation of water quality conditions with respect to the 2,000 µg/L objective (Appendix 8F, Table Bo-4). Consequently, boron levels that may occur under the No Action Alternative LLT, relative to existing conditions and the No Action Alternative NT, would not be expected to adversely affect municipal water supply beneficial uses of the Delta.

Similarly, under the No Action Alternative LLT, the long-term annual average and monthly average boron concentrations for either the 16-year period or drought period modeled would never exceed the lowest agricultural objective of 500 µg/L contained in the San Francisco Bay RWQCB (Region 2) Basin Plan at any Delta assessment location except at the Sacramento River at Mallard Island and San Joaquin River at Antioch locations (Appendix 8F, Table Bo-3). However, the agricultural beneficial use is not an existing designated use at Mallard Island within the Region 2 Basin Plan, and the Antioch location is in the far western Delta and not a location of agricultural diversions (DWR 1993). Small reductions in the modeled long-term average assimilative capacity would occur only at the Jones and Banks pumping plants, Old River at Rock Slough, and Sacramento River at Emmaton locations (e.g., maximum reduction of 3% at Jones Pumping Plant for both the 16-year and drought periods modeled) (Appendix 8F, Table Bo-5). Moreover, the reduced assimilative capacity would not lead to an increased frequency of exceedances of objectives because the absolute concentrations would be well below the lowest 500 µg/L objective for the protection of agricultural beneficial uses, as indicated in plots of monthly average boron concentrations for representative interior and south Delta locations (i.e., Franks Tract, Old River at Rock Slough, Jones Pumping Plant, and Old River at Tracy Road) (Appendix 8F, Figure Bo-2). Consequently, the small increases in average boron concentrations that may occur under the No Action Alternative LLT, relative to existing conditions and the No Action Alternative NT, would not be expected to adversely affect municipal or agricultural water supply beneficial uses of the Delta, or substantially degrade water quality with respect to boron.

SWP/CVP Export Service Areas

Under the No Action Alternative LLT, relatively small increases would occur in long-term average boron concentrations at the Jones and Banks pumping plants relative to the existing conditions and No Action Alternative NT (i.e., up to 4% at Jones pumping plant for both the 16-year and drought period modeled) (Appendix 8F, Table Bo-2). With respect to the 303(d) listing of the lower San Joaquin River impairment for boron, increased boron concentrations in exported water to the San

Joaquin River basin could lead to increased loading in the lower San Joaquin River since boron is principally related to irrigation water deliveries. However, the absolute average boron concentrations at Jones Pumping Plant would be low relative to applicable objectives (Appendix 8F, Figure Bo-2), and the reduction in assimilative capacity would be minor (i.e., 4% reduction for the drought period modeled) compared to either the existing conditions or No Action Alternative NT conditions (Appendix 8F, Table Bo-5). Thus, the long-term increased boron concentrations would not be expected to cause further measurable degradation in the lower San Joaquin River that would make the existing impairment discernibly worse or adversely affect necessary TMDL actions implemented to reduce boron loading. Consequently, the small increases in average boron concentrations that may occur under the No Action Alternative LLT, relative to existing conditions and the No Action Alternative NT, would not be expected to adversely affect municipal or agricultural water supply beneficial uses in the SWP and CVP service area, or substantially degrade water quality with respect to boron.

***CEQA Conclusion*:** Boron is not a bioaccumulative constituent, thus any increased concentrations under the No Action Alternative LLT would not result in adverse boron bioaccumulation effects to aquatic life or humans. Relative to existing conditions, the No Action Alternative LLT would not result in any substantial increase in boron concentrations upstream of the Delta. With respect to the 303(d) listing of boron in the lower San Joaquin River for the agricultural water supply beneficial use, the potential small increase in long-term average boron concentration associated with reduced flows and exported water at the Jones Pumping Plant would not be expected to cause further degradation at measurable levels in the lower San Joaquin River, and thus would not cause the existing impairment to be discernibly worse. Relative to existing conditions, the No Action Alternative LLT would not result in substantially increased boron concentrations such that frequency of exceedances of municipal and agricultural water supply objectives would increase. The levels of boron degradation that may occur under the No Action Alternative LLT would not be of sufficient magnitude to cause substantially increased risk of exceeding objectives or adverse effects to municipal or agricultural beneficial uses, or any other beneficial uses, within the affected environment. Based on these findings, this impact is determined to be less than significant.

Additional Conservation Measures

Under the No Action Alternative, existing policies and programs would be continued and none of the CM2–CM22 associated with the action alternatives would be implemented.

Impact WQ-5: Effects on bromide concentrations resulting from facilities operations and maintenance (CM1)

Upstream of the Delta

Under the No Action Alternative LLT, greater water demands will alter the magnitude and timing of reservoir releases upstream of the Delta, relative to existing conditions and No Action Alternative NT. As shown in Table 8-47, the Sacramento River watershed and eastside tributaries are negligible sources of bromide to the Delta. While greater water demands under the No Action Alternative LLT would alter the magnitude and timing of reservoir releases north and east of the Delta, these activities would have negligible, if any, effect on the sources, and ultimately the concentration of bromide in the Sacramento River, the eastsidetributaries, and the various reservoirs of the related watersheds. Consequently, the No Action Alternative LLT would not be expected to adversely affect the MUN beneficial use, or any other beneficial uses, of the Sacramento River, the eastside tributaries, or their associated reservoirs upstream of the Delta.

South of the Delta, the San Joaquin River is a substantial source of bromide. While tributaries and associated reservoirs of the lower San Joaquin are likely negligible sources of bromide, bromide on the lower San Joaquin is relatively high and can be sourced to agriculture using irrigation water imported from the southern Delta. This "recirculation" of bromide is the primary source of bromide on the lower San Joaquin River, where concentrations at Vernalis are inversely correlated to net river flow and the dilution provided by this flow. Under the No Action Alternative LLT, long-term average flows at Vernalis would decrease 6% relative to existing conditions and 5% relative to No Action Alternative NT (Appendix 5A). Based on best-fit regressions of San Joaquin River flow and bromide, these decreases in flow would correspond to a possible increase in long-term average bromide of about 3% relative to existing conditions and about 2% relative to No Action Alternative NT. The relatively small magnitude of this increase is considered to be less than substantial. Moreover, there are no existing municipal intakes on the lower San Joaquin River. Consequently, the small increases in lower San Joaquin River bromide levels that may occur under the No Action Alternative LLT, relative to existing conditions and the No Action Alternative NT, would not be expected to adversely affect the MUN beneficial use, or any other beneficial uses, of the lower San Joaquin River.

Delta

Relative to existing conditions, the No Action Alternative LLT would result in small decreases in long-term average bromide concentrations at all modeled Delta assessment locations with the exception being the Sacramento River at Emmaton for the drought period. For the modeled drought period, long-term bromide concentrations at Emmaton are predicted to increase by about 8%.

The modeled frequency with which bromide concentration exceeds 50 and 100 μg/L would change only slightly at all 11 assessment locations, with some Delta assessment locations experiencing improved water quality relative to bromide. However, small increases in modeled concentration threshold exceedances would occur at some Delta interior and western Delta assessment locations. In the Delta interior at Rock Slough and Franks Tract, the frequency of exceeding 100 μg/L would increase by a maximum of about 3 percentage points (4 percentage points for modeled drought period). Larger increases would occur in the western Delta, however, where the frequency of exceeding 100 μg/L would increase by as much as 7 percentage points at Emmaton (2 percentage points for modeled drought period) (Appendix 8E, Bromide Table 2-3). The greater frequencies of exceedance can be sourced primarily to the assumptions of sea level rise in the late long-term. While the greater influence of sea water would result in slightly more frequent bromide conditions exceeding 50 and 100 μg/L in these select interior and western Delta locations, the resulting conditions would not be expected to adversely affect MUN beneficial uses, or any other beneficial use, particularly when considering the relatively small change in long-term annual average concentration.

Relative to No Action Alternative NT, the No Action Alternative LLT would generally result in small decreases in long-term annual average bromide at Staten Island and Buckley Cove in the eastern Delta, as well the Banks and Jones pumping plants. In contrast, long-term average bromide at the 7 other Delta assessment locations would be predicted to increase, with the greatest predicted increase of 11% (18% in drought years) occurring at Emmaton (Appendix 8E, Bromide Table 2-3). Increases in long-term average bromide at these select locations would correspond to slightly more frequent water quality conditions exceeding bromide concentration thresholds. The largest increase would occur at Rock Slough, Franks Tract, and Emmaton, where the modeled frequency of bromide exceeding 100 μg/L during the drought period would increase by as much as 7 percentage points. Relative to the existing condition comparison, the slightly greater magnitude increases discussed relative to the No Action Alternative NT comparison can be sourced to the combined effects of sea level rise and Fall X2. While the comparison to No Action Alternative NT predicts slightly greater magnitude increase in bromide at select assessment locations, these conditions would not be expected to adversely affect MUN beneficial uses, or any other beneficial use, in the Delta.

The seasonal intakes at Mallard Slough and City of Antioch are infrequently used due to water quality constraints related to sea water intrusion. On a long-term average basis, bromide at these locations is in excess of 3,000 μg/L, but during seasonal periods of high Delta outflow can be <300 μg/L. Given these seasonal constraints on use, mass balance modeling predicts that use of these intakes would most frequently occur during the months of February, March, and April of wet and above normal water year types when water quality suitable for diversion would be most typically available. Focusing on this period of most likely seasonal use (February–April of wet and above normal water years), under the No Action Alternative LLT average bromide concentrations would increase about 5% relative at the City of Antioch intake and would decrease about 4% at the Mallard Slough intake relative to both existing and No Action Alternative NT conditions (Appendix 8E, Bromide Figure 2-3). Such a relatively small predicted increase in bromide concentrations at the City of Antioch intake would not be expected to adversely affect MUN beneficial uses, or any other beneficial use, while decreases at Mallard Slough would be considered beneficial.

SWP/CVP Export Service Areas

Under the No Action Alternative LLT, long-term average bromide concentrations at the Banks and Jones pumping plants would decrease by as much as 13% relative to existing conditions and 5% relative to No Action Alternative NT (Appendix 8E, Bromide Table 2-3). The frequency with which bromide would exceed bromide concentration thresholds at the Banks and Jones pumping plants, relative to existing conditions and No Action Alternative NT, would remain unchanged or would improve slightly, including years of drought. Consequently water exported into the SWP/CVP Export Service Areas through these south Delta pumps would be of similar or slightly better quality with regards to bromide under the No Action Alternative LLT, relative to both existing conditions and the No Action Alternative NT.

Maintenance of SWP and CVP facilities under the No Action Alternative LLT would not be expected to create new sources of bromide or contribute towards a substantial change in existing sources of bromide in the affected environment. Maintenance activities would not be expected to cause any substantial change in bromide such that MUN beneficial uses, or any other beneficial use, would be adversely affected anywhere in the affected environment.

Additional Conservation Measures

Under the No Action Alternative, existing policies and programs would be continued and none of the CM2–CM22 associated with the action alternatives would be implemented.

CEQA Conclusion: Relative to existing conditions, the No Action Alternative LLT would not cause exceedance of applicable state or federal numeric or narrative water quality objectives/criteria because none exist for bromide. The No Action Alternative LLT would not result in any substantial change in long-term average bromide concentration or exceed 50 and 100 μg/L assessment threshold concentrations by frequency, magnitude, and geographic extent that would result in adverse effects on any beneficial uses within affected water bodies. Bromide is not a bioaccumulative constituent and thus concentrations under this alternative would not result in bromide bioaccumulating in aquatic organisms. Increases in exceedances of the 100 µg/L assessment threshold concentration would be 8% or less at all locations assessed, which is considered to be less-than substantial long-term degradation of water quality. The levels of bromide degradation that may occur under the No Action Alternative LLT would not be of sufficient magnitude to cause substantially increased risk for adverse effects on any beneficial uses of water bodies within the affected environment. Bromide is not 303(d) listed and thus the minor increases in long-term average bromide concentrations would not affect an existing beneficial use impairment because no such use impairment currently exists for bromide. Based on these findings, this impact is less than significant. No mitigation is required.

Impact WQ-7: Effects on chloride concentrations resulting from facilities operations and maintenance

Upstream of the Delta

Under the No Action Alternative LLT, greater water demands and climate change would alter the magnitude and timing of reservoir releases and river flows upstream of the Delta in the Sacramento River watershed and eastside tributaries, relative to existing conditions and No Action Alternative NT. Because substantial sources of chloride do not exist upstream of the Delta, concentrations of chloride in surface water are low and often below detection limits (see Table Cl-2 and "Affected Environment-Environmental Setting" section). Consequently, changes in the magnitude and timing of reservoir releases and river flows upstream of the Delta would have negligible, if any, effect on chloride sources, and ultimately the concentration of chloride in the Sacramento River, the eastside tributaries, and the various reservoirs of the related watersheds. Consequently, the No Action Alternative LLT would not be expected to cause exceedance of chloride objectives/criteria or substantially degrade water quality with respect to chloride and thus would not adversely affect any beneficial uses of the Sacramento River, the eastside tributaries, or their associated reservoirs upstream of the Delta.

South of the Delta, the San Joaquin River has generally elevated chloride concentrations compared to the Sacramento River and east side tributaries, however, average monthly and maximum concentrations are below the applicable drinking water MCL of 250 mg/L and the EPA chronic aquatic life criterion of 230 mg/ (Table Cl-2). The chloride in the lower San Joaquin River can be sourced to "recirculation" of salts in agricultural drainage from irrigation water imported from the southern Delta. Chloride concentrations at Vernalis are inversely correlated to net river flow and the dilution provided by the flow. Under the No Action Alternative LLT, long-term average flows at Vernalis would decrease by an estimated 6% relative to existing conditions and 5% relative to the No Action Alternative NT (cross-reference to Modeling Data Appendix, CALSIM Flow Data for Vernalis). Based on best-fit regressions of San Joaquin River flow and chloride, these decreases in flow would correspond to a potential increase in long-term average chloride concentrations of about 2% relative to both the existing conditions and the No Action Alternative NT conditions. The relatively small increase would not cause chloride concentrations to exceed applicable objectives relative to existing concentrations or the No Action Alternative NT conditions and would not substantial long-term water quality degradation with regards to chloride. Moreover, there are no existing municipal supply intakes on the lower San Joaquin River. Consequently, the small increases in lower San Joaquin River chloride levels that may occur under the No Action Alternative LLT, relative to existing conditions and the No Action Alternative NT, would not be expected to adversely affect any beneficial uses of the lower San Joaquin River.

Delta

Relative to existing conditions, the No Action Alternative LLT would result in small decreases in long-term average chloride concentrations for the 16-year period modeled (i.e., 1976-1991) at the eleven Delta assessment locations (Appendix 8G, Table Cl-1). In the months of February through June, monthly average chloride concentrations would increase at all of the assessment locations except two interior Delta locations (i.e., SF Mokelumne River at Staten Island and San Joaquin River at Buckley Cove). For the other months of the year (i.e., July through January), the changes in chloride concentrations would be variable with increases and decreases occurring at all eleven assessment locations. The Sacramento River at Emmaton location in the western Delta would exhibit the largest seasonal increases compared to existing conditions, ranging from 11% to 48% during the months of December through June. For the drought year period modeled (i.e., 1987–1991), the annual average chloride concentration would remain unchanged or decrease at ten of the assessment locations, but increase by about 12% compared to existing conditions at the Sacramento River at Emmaton location (Appendix 8G, Table Cl-1). The following outlines the modeled chloride changes relative to the applicable objectives and effects on beneficial uses in Delta waters.

Municipal and Industrial Beneficial Uses

There are two chloride objectives for protection of this use: (1) a 150 mg/L objective that applies a certain number of days per calendar year at the Contra Costa Canal at Pumping Plant #1 or San Joaquin River at Antioch; and (2) a 250 mg/L objective that applies year-round at five specified municipal intake locations (refer to Table Cl-1). The 150 mg/L Bay-Delta WQCP objective varies with water year type and effectively requires compliant chloride concentrations for approximately 8 months for the wet years, 7 months for above normal years, 6 months for either below normal or dry years, and 5 months for critical years. Qualitativereview of the plots of monthly average chloride concentrations at the Contra Costa Canal at Pumping Plant #1 for the separate water year types in the 16-year period modeled indicates that the number of months above the objective would either remain unchanged or decrease slightly under all water year types, thus indicating there would not be an increased potential for exceedance of this objective under the No Action Alternative LLT relative to existing conditions (Appendix 8G, Figure Cl-1). The modeled chloride concentrations at the San Joaquin River at Antioch location would never meet this objective under the No Action Alternative LLT; however, this represents no change from the existing conditions.

With respect to the 250 mg/L chloride objective, the modeled monthly average chloride concentrations at the Barker Slough at North Bay Aqueduct for the 16-year period would not exceed the objective, which represents no change from the existing conditions (Appendix 8G, Table Cl-2). The modeled frequency of exceedances at the Banks pumping plant would decrease slightly from 4% under existing conditions to 2%. At the Contra Costa Canal at Pumping Plant #1, the modeled frequency of exceedances of this objective would decrease about 10% from 24% to 14%. Chloride concentrations in the western Delta can exceed the applicable 250 mg/L objective frequently in the low-flow fall and early winter months under existing conditions. Consequently, water is diverted from the San Joaquin River at Antioch and Mallard Slough municipal intakes only when salinity conditions are acceptable. The frequency of exceedances of the objective at the San Joaquin at Antioch location for the 16-year period modeled would increase from 66% under existing conditions to 73% for a net increase of about 7% and would increase 1% (i.e., from 85% under existing conditions to 86%) at the Sacramento River at Mallard Island location. Moreover, the increased chloride concentrations would occur during the months of January through June, thus reducing water quality during the period of seasonal municipal diversions (Appendix 8G, Figure Cl-2). The available assimilative capacity would decrease substantially at the Antioch location in the months of March and April (i.e., maximum reduction of 39% for the 16-year period modeled and 97% for the drought period only) when chloride concentrations would be near, or exceed, the objectives, thus increasing the risk of exceeding objectives (Appendix 8G, Table Cl-3). Based on the additional seasonal exceedances of the municipal objective and magnitude of long-term average water quality degradation with respect to chloride at Antioch, the potential exists for substantial adverse effects on the municipal and industrial water supply beneficial uses through reduced opportunity for diversion of water at Antioch and Mallard Slough with acceptable salinity.

Aquatic Life Beneficial Uses

Relative to the 230 mg/L chronic EPA aquatic life criterion, the modeled monthly average chloride concentrations at the assessment locations representative of the north and east regions of the Delta (e.g., Barker Slough at North Bay Aqueduct, Mokelumne River SF at Staten Island, and San Joaquin River at Buckley Cove) would never exceed the criterion for the 16-year period modeled under the No Action Alternative LLT, which represents no change from the existing conditions (Appendix 8G, Table Cl-2). The modeled frequency of exceedances of the criterion at southern locations (e.g., Banks and Jones pumping plants) and at interior locations (e.g., Franks Tract and Old River at Rock Slough) would generally decrease. For example, exceedances at the Banks pumping plant would decrease from 8% under existing conditions to 4% for the 16-year modeled period, and would decrease at Franks Tract from 38% under existing conditions to 27%. Reductions in the modeled assimilative capacity would occur at some locations during the January through June period of the drought period modeled (e.g., maximum reduction of 15% at Franks Tract and 10% at Old River at Rock Slough) (Appendix 8G, Table Cl-4). However, the reduced assimilative capacity would not result in substantial adverse effects on aquatic organisms because the absolute concentrations during these months would be less than the criteria (Appendix 8G, Figure Cl-3).

303(d) Listed Water Bodies

Tom Paine Slough in the southern Delta is on the 303(d) list for chloride with respect to the secondary MCL of 250 mg/L. The plot of monthly average chloride concentrations at the Old River at Tracy Bridge for the 16-year period modeled, which represents the nearest DSM2-modeled location to Tom Paine in the south Delta, would be well below the MCL and generally would be similar, or reduced slightly, compared to existing conditions (Appendix 8G, Figure Cl-3).

The Suisun Marsh wetlands is on the 303(d) list for chloride in association with the Bay-Delta WQCP objectives for maximum allowable salinity during the months of October through May, which establish appropriate seasonal salinity conditions for fish and wildlife beneficial uses. The Sacramento River at Mallard Island, Sacramento River at Collinsville, and Montezuma Slough at Beldon's Landing within the marsh, are DSM2-modeled locations representative of source water quality conditions for the marsh that is supported by inflowing flood tide waters from the west, and ebb tide flows of Sacramento River water into Montezuma Slough through the Suisun Marsh Salinity Control Gates located near the Collinsville location. Long-term average chloride concentrations at the Sacramento River at the Mallard Island location for the 16-year period modeled would decrease slightly by 140 mg/L (-5%) compared to existing conditions (Appendix 8G, Table Cl-1). The plots of monthly average chloride concentrations for the Sacramento River at Collinsville (Appendix 8G,

Figure Cl-4) and Montezuma Slough at Beldon's Landing (Appendix 8G, Figure Cl-4) for the 16-year period modeled indicate that, compared to existing conditions, chloride concentrations would be similar or lower during the months of October through May. Consequently, chloride concentrations at Tom Paine Slough and Suisun Marsh would not be further degraded on a long-term basis or adversely affect necessary actions to reduce chloride loading for any TMDLs developed.

Relative to the No Action Alternative NT, the No Action Alternative LLT would result in either no change or small reductions in long-term annual average chloride concentrations at eight of the assessment locations for the 16-year period modeled (Appendix 8G, Table Cl-1). Long-term average chloride concentrations for the 16-year period modeled would increase at the three assessed western Delta locations (i.e., Antioch, Emmaton, and Mallard Island). For the drought period modeled, long-term average chloride concentrations would increase at the three western Delta locations and at the interior locations of Franks Tract, Old River at Rock Slough, and the Contra Costa Canal at Pumping Plant #1 compared to the No Action Alternative NT conditions. The modeled chloride changes relative to the applicable objectives and potential effects on beneficial uses are as follows.

SWP/CVP Export Service Areas

Under the No Action Alternative LLT, long-term average chloride concentrations at the Banks and Jones pumping plants would decrease by as much as 12% relative to existing conditions and 4% relative to No Action NT for the 16-year period modeled (Appendix 8G, Chloride Table Cl-1). The modeled frequency of exceedances of applicable water quality objectives/criteria would decrease at the Banks and Jones pumping plants, relative to existing conditions and No Action NT, for both the 16-year period modeled and the drought period (Appendix 8G, Chloride Table Cl-2). Consequently, water exported into the SWP and CVP service area would generally be of similar or slightly better quality with regards to chloride under the No Action Alternative LLT, relative to both existing conditions and the No Action Alternative NT.

Maintenance of SWP and CVP facilities under the No Action Alternative LLT would not be expected to create new sources of chloride or contribute towards a substantial change in existing sources of chloride in the affected environment. Maintenance activities would not be expected to cause any substantial change in chloride such that any beneficial uses would be adversely affected anywhere in the affected environment.

CEQA Conclusion: Chloride is not a bioaccumulative constituent, thus any increased concentrations under the No Action Alternative LLT would not result in adverse chloride bioaccumulation effects to aquatic life or humans. Relative to existing conditions, the No Action Alternative LLT would not result in any substantial changes in chloride concentration upstream of the Delta or in the SWP and CVP service area. With respect to the 303(d) listings, the average chloride concentrations would generally be similar compared to existing conditions, and small increases would not cause further degradation on a long-term basis that would adversely affect necessary actions to reduce chloride loading for any TMDLs developed for Tom Paine Slough and Suisun Marsh wetlands. Relative to existing conditions, the No Action Alternative LLT would result in substantially increased chloride concentrations such that frequency of exceedances of the 250 mg/L Bay-Delta WQCP objective would increase at the San Joaquin River at Antioch (by 7%) and at Mallard Slough (by 1%), and long-term degradation may occur, that may result in adverse effects on the municipal and industrial water supply beneficial use. Based on these findings, this impact is determined to be potentially significant due to increased chloride concentrations and objective exceedances, and additional long-term degradation, in the western Delta and associated effects on the municipal and industrial water supply beneficial uses.

Additional Conservation Measures

Under the No Action Alternative, existing policies and programs would be continued and none of the CM2–CM22 associated with the action alternatives would be implemented.

Impact WQ-9: Effects on dissolved oxygen resulting from facilities operations and maintenance

Upstream of the Delta

DO levels in the reservoirs and rivers upstream of the Delta are primarily affected by water temperature, flow velocity, turbulence, amounts of oxygen demanding substances present (e.g., ammonia, organics), and rates of photosynthesis (which is influenced by nutrient levels), respiration, and decomposition. Water temperature and salinity affect the maximum DO saturation level (i.e., the highest amount of oxygen the water can dissolve). Flow velocity affects the turbulence and re-aeration of the water (i.e., the rate at which oxygen from the atmosphere can be dissolved in water). High nutrient content can support aquatic plant and algae growth, which in turn generates oxygen through photosynthesis and consumes oxygen through respiration and decomposition.

As described in the affected environment section, DO in the Sacramento River at Keswick, Feather River at Oroville, and lower American River ranged from 7.3 to 15.6 mg/L, 7.4 to 12.5 mg/L, and 6.5 to 13.0 mg/L, respectively. The Reclamation temperature model results generally indicate that overall monthly mean Sacramento River, Feather River, and American River temperatures would increase under the No Action Alternative LLT compared to existing conditions. It is possible that this increase in temperature could decrease the maximum oxygen saturation level of the Sacramento River, Feather River, and American River, and those increases in temperature may also promote further algal or vegetative growth such that DO levels may have greater diurnal fluctuation in localized areas. Because there are occasional periods when the DO objectives are not met under existing conditions, there may periods when DO objectives are not met under the No Action Alternative. However, when holding constant for barometric pressure and other biochemical factors affecting DO, for the 60°F range of water temperatures in freshwater, every 1.8°F temperature increase could be anticipated to reduce the DO saturation level by about 0.2 mg/L (Wetzel 1983). Hence, long-term average temperature increases of 2°F or less would be expected to produce negligible and typically immeasurable changes in DO levels and DO levels would fluctuate within the range observed historically.

An effect on salinity (expressed as EC and TDS) would not be expected in the rivers and reservoirs upstream of the Delta. Thus, these parameters would not be expected to measurably change DO levels under the No Action Alternative LLT, relative to existing conditions.

The No Action Alternative LLT would alter the magnitude and timing of water releases from reservoirs upstream of the Delta relative to existing conditions, altering downstream river flows. There would be some increases and decreases in the mean monthly river flows, depending on month and year. Mean monthly flows would remain within the range historically seen under existing conditions. Moreover, these are large, turbulent rivers with flow rates typically in the range of 0.5 fps to 2.0 fps or higher. Consequently, flow changes that would occur under the No Action Alternative LLT would not be expected to have substantial effects on river DO levels; likely, the changes would be immesurable. This is because sufficient turbulence and interaction of river water with the atmosphere would continue to occur under this alternative to maintain water saturation levels (due to these factors) at levels similar to that of existing conditions.

Amounts of oxygen demanding substances present (e.g., ammonia, organics) in the reservoirs and rivers upstream of the Delta, rates of photosynthesis (which is influenced by nutrient levels/loading), and respiration and decomposition of aquatic life is not expected to change sufficiently under the No Action Alternative LLT to substantially alter DO levels relative to existing conditions. Any minor reductions in DO levels that may occur under this alternative would not be expected to be of sufficient frequency, magnitude and geographic extent to adversely affect beneficial uses, or substantially degrade the quality of these water bodies, with regard to DO.

For the same reasons given above, the No Action Alternative LLT is expected to have no substantial, and likely immeasurable, effects on DO levels in reservoirs and rivers upstream of the Delta relative to the No Action Alternative NT.

Delta

Similar to the reservoirs and rivers upstream of the Delta, DO levels in the Delta are primarily affected by water temperature, salinity, Delta channel flow velocities, nutrients (i.e., phosphorus and nitrogen) and aquatic organisms (i.e., photosynthesis, respiration, and decomposition). Sediment oxygen demand of organic material deposited in the low velocity channels also affects Plan Area DO levels.

Under the No Action Alternative LLT, minor DO level changes could occur due to nutrient loading to the Delta relative to existing conditions (cross reference to nutrient Numbered Impact in this chapter). The state has begun to aggressively regulate point-source discharge effects on Delta nutrients, and is expected to further regulate nutrients upstream of and in the Delta in the future. Although population increased in the affected environment between 1983 and 2001, average monthly DO levels during this period of record show no trend in decline in the presence of presumed increases in anthropogenic sources of nutrients (see Table 4.4-15 in the ES/AE section). Based on these considerations, excessive nutrients that would cause low DO levels in the would not be expected to occur under the No Action Alternative LLT.

Various areas of the Delta could experience salinity increases due to change in quantity of Delta inflows (cross reference to EC Numbered Impact in this chapter). For a 5 ppt salinity increase at 68°Fahrenheit, the saturation level of oxygen dissolved in the water is reduced by only about 0.25 mg/L. Thus, increased salinity under the No Action Alternative LLT would generally have relatively minor effects on Delta DO levels where salinity is increased on the order of 5 ppt or less.

The relative degree of tidal exchange of flows and turbulence, which contributes to exposure of Delta waters to the atmosphere for reaeration, would not be expected to substantially change relative to existing conditions, such that these factors would reduce Delta DO levels below objectives or levels that protect beneficial uses.

Some waterways in the eastern, southern, and western Delta are listed on the state's Clean Water Act section 303(d) list as impaired due to low oxygen levels. ATMDL for the Deep Water Ship channel in the eastern Delta has been approved and identifies the factors contributing to low DO in the Deep Water Ship Channel as oxygen demanding substances from upstream sources, Deep Water Ship Channel geometry, and reduced flow through the Deep Water Ship Channel (Central Valley Regional Water Quality Control Board 2005:28). The TMDL takes a phased approach to allow more time to gather additional informational on source and linkages to the DO impairment, while at the same time moving forward on making improvements to DO conditions. One component of the TMDL implementation activities is an aeration device demonstration project. It is expected that under the No Action Alternative LLT that DO levels in the Deep Water Ship Channel would remain similar to those under existing conditions or improve as the TMDL-required studies are completed and actions are implemented to improve DO levels. DO levels in other Clean Water Act section 303(d)-listed waterways would not be expected to change relative to existing conditions, as the circulation of flows, tidal flow exchange, and re-aeration would continue to occur similar to existing conditions.

For the same reasons given above, the No Action Alternative LLT is expected to have no substantial, and likely immeasurable, effects on DO levels in the Delta relative to the No Action Alternative NT.

SWP/CVP Export Service Areas

The primary factor that would affect DO in the conveyance channels and ultimately the receiving reservoirs in the SWP/CVP Export Service Areas would be changes in the levels of nutrients and oxygen-demanding substances and DO levels in the exported water. For reasons provided above, the Delta waters exported to the SWP/CVP Export Service Areas would not be expected to be substantially lower in DO compared to existing conditions. Exported water could potentially be warmer and have higher salinity relative to existing conditions. Nevertheless, because the biochemical oxygen demand of the exported water would not be expected to substantially differ from that under existing conditions (due to ever increasing water quality regulations), canal turbulence and exposure of the water to the atmosphere and the algal communities that exist within the canals would establish an equilibrium for DO levels within the canals. The same would occur in downstream reservoirs. Consequently, substantial adverse effects on DO levels in the SWP/CVP Export Service Areas would not be expected to occur under the No Action Alternative LLT relative to existing conditions.

For the same reasons given above, substantial adverse effects on DO levels in the SWP/CVP Export Service Areas would not be expected to occur under the No Action Alternative LLT relative to the No Action Alternative NT.

CEQA Conclusion: There would be no substantial, and likely no measurable, long-term change in DO levels Upstream of the Delta, in the Plan Area, or the SWP/CVP Export Service Areas under the No Action Alternative LLT relative to existing conditions. As such, this alternative is not expected to cause additional exceedance of applicable water quality objectives by frequency, magnitude, and geographic extent that would adversely affect beneficial uses. Because no substantial changes in DO levels are expected, long-term water quality degradation would not be expected, and, thus, beneficial uses would not be expected to be adversely affected. Various Delta waterways are Clean Water Act section 303(d)-listed for low DO, but because no substantial decreases in DO levels are expected, greater degradation and impairment of these areas is not expected to occur. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-11: Effects on electrical conductivity concentrations resulting from facilities operations and maintenance

Upstream of the Delta

The No Action Alternative LLT would alter the magnitude and timing of water releases from reservoirs upstream of the Delta relative to existing conditions, altering downstream river flows relative to existing conditions. With respect to EC, an increase or decrease in river flow alone is not of concern. Measureable changes in the quality of the watershed runoff and reservoir inflows would not be expected to occur in the future; therefore, the EC levels in these reservoirs would not be expected to change relative to existing conditions. There could be increased discharges of EC-elevating parameters in the future in water bodies upstream of the Delta as a result of urban growth and increased runoff and wastewater discharges. The state has begun to aggressively regulate point-source discharge effects on Delta salinity-elevating parameters, capping dischargers at existing levels, and is expected to further regulate EC and related parameters upstream of and within the Delta in the future as salt management plans are developed.

Based on these considerations, EC levels (highs, lows, typical conditions) in the Sacramento River and its tributaries, the eastside tributaries, or their associated reservoirs upstream of the Delta would not be expected to be outside the ranges occurring under existing conditions. For the same reasons, the No Action Alternative LLT would be expected to have minimal effect on EC concentrations in the Sacramento River and its tributaries, the eastside tributaries, or their associated reservoirs upstream of the Delta relative to the No Action Alternative NT.

The effects on lower San Joaquin River EC would be somewhat different. Elevated EC in the San Joaquin River can be sourced to agriculture using irrigation water imported from the southern Delta and applied on soils high in salts. This "recirculation" of salts is a primary contributor of elevated EC on the lower San Joaquin River. Tributary flows generally provide dilution of the high EC agricultural drainage waters. Under the No Action Alternative LLT, long-term average flows at Vernalis would decrease 6% relative to existing conditions and 5% relative to the No Action Alternative NT (Appendix 5A). These decreases in flow, alone, would correspond to a possible increase in long-term average EC levels relative to existing conditions and the No Action Alternative NT. The level of EC increase cannot be readily quantified but, based on estimated increase in bromide and chloride concentrations, to which EC is correlated, would be relatively small and on the order of about 3%. However, with the implementation of the adopted TMDL for the San Joaquin River at Vernalis and the ongoing development of the TMDL for the San Joaquin River upstream of Vernalis and its implementation, it is expected that EC levels would be improved under the No Action Alternative LLT relative to existing conditions. Based on these considerations, substantial changes in EC levels in the San Joaquin River relative to existing conditions would not be expected of sufficient magnitude and geographic extent that would result in adverse effects on any beneficial uses, or substantially degrade the quality of these water bodies, with regard to EC. For the same reasons, substantial changes in EC levels in the San Joaquin River under the No Action Alternative LLT relative to the No Action Alternative NT would not be expected to be of sufficient magnitude and geographic extent that would result in adverse effects on any beneficial uses, or substantially degrade the quality of these water bodies, with regard to EC.

Delta

Relative to existing conditions, the No Action Alternative LLT would result in a fewer number of days when Bay-Delta WQCP compliance locations in the western, interior, and southern Delta would exceed EC objectives or be out of compliance with the EC objectives, with the exception of the Sacramento River at Emmaton (Appendix H, Table EC-1). The percent of days the Emmaton EC objective would be exceeded for the entire period modeled (1976–1991) would increase from 6% under existing conditions to 12% under the No Action Alternative LLT. Further, the percent of days out of compliance with the EC objective would increase from 11% under existing conditions to 22% under the No Action Alternative LLT. Average EC levels at the western, interior, and southern Delta compliance locations, other than the Sacramento River at Emmaton, would decrease from 1–14% for the entire period modeled and 0–7% during the drought period modeled (1987–1991) (Appendix H, Table EC-11). Average EC in the Sacramento River at Emmaton would increase 1% for the entire period modeled and 10% during the drought period modeled. On average, EC would increase at Emmaton during all months, except October and November (Appendix H, Table EC-11).

Relative to the No Action Alternative NT, the change in percent compliance with Bay-Delta WQCP EC objectives under the No Action Alternative LLT would be similar to that described above relative to existing conditions. The exception is that there would also be a slight increase (1% or less) in the percent of days the EC objective would be exceeded in the San Joaquin River at Vernalis and Brandt Bridge, and in Old River near Middle River, located in the southern Delta, for the entire period modeled. For the entire period modeled, average EC levels would increase at several Delta compliance locations relative to the No Action Alternative NT: Sacramento River at Emmaton (11%); San Joaquin River at San Andreas Landing (4%); San Joaquin River at Vernalis (3%); San Joaquin River at Brandt Bridge (3%); Old River at Middle River (3%); and Old River at Tracy Bridge (3%) (Appendix H, Table EC-11). During the drought period modeled, the list of locations with increased EC relative to the No Action Alternative NT is somewhat different: Sacramento River at Emmaton (15%); San Joaquin River at Jersey Point (5%); San Joaquin River at San Andreas Landing (7%); San Joaquin River at Vernalis (1%); Old River at Middle River (1%); and San Joaquin River at Prisoners Point (1%) (Appendix H, Table EC-11).

In Suisun Marsh, average EC for the entire period modeled would increase under the No Action Alternative LLT, relative to existing conditions, during the months of January through May by 0.1-0.7 mS/cm, depending on the location and month (Appendix H, Table EC-21 through Table EC-25). The degree to which the average EC increases would cause exceedance of Bay-Delta WQCP objectives is unknown, because objectives are expressed as a monthly average of daily high tide EC, which does not have to be met if it can be demonstrated "equivalent or better protection will be provided at the location" (State Water Resources Control Board 2006:14). The described long-term average EC increase may, or may not, contribute to adverse effectson beneficial uses, depending on how and when wetlands are flooded, soil leaching cycles, and how recirculation of water is managed, and future actions taken with respect to the Marsh. Given the Bay-Delta WQCP narrative objective regarding "equivalent or better protection" in lieu of meeting specific numeric objectives, the small increase in EC relative to existing conditions would not be expected to adversely affect beneficial uses of Suisun Marsh under the No Action Alternative LLT. Similarly, the No Action Alternative LLT would not be expected to adversely affected beneficial uses of Suisun Marsh relative to the No Action Alternative NT.

Given that the western and southern Delta is Clean Water Act section 303(d) listed as impaired due to elevated EC, the increase in the incidence of exceedance of EC objectives and average EC levels at western and southern Delta locations under the No Action Alternative LLT, relative to existing conditions and the No Action Alternative NT and LLT, has the potential to contribute to additional impairment and adversely affect beneficial uses. While Suisun Marsh also is Section 303(d) listed as impaired because of elevated EC, the potential increases in long-term average EC concentrations, relative to existing conditions and the No Action Alternative NT and LLT, would not be expected to contribute to additional impairment, because the increase would be so small (<1 mS/cm) as to not be measurable and beneficial uses would not be adversely affected.

SWP/CVP Export Service Areas

At the Banks pumping plant, relative to existing conditions, the No Action Alternative LLT would result in no additional exceedances of the Bay-Delta WQCP's 1,000 µmhos/cm EC objective during the drought period modeled; the frequency of exceedance for both conditions would be 2% (Appendix H, Table EC-10). When the entire period modeled is considered, the frequency of exceedances of the EC objective would increase slightly, from 1% under existing conditions to 2% under the No Action Alternative LLT (Appendix H, Table EC-10). Because the EC objective is for agricultural beneficial use protection, for which longer-term crop exposure to elevated EC waters is a concern, this minimal increase in frequency of exceedance of the EC objective would not adversely affect this beneficial use. Relative to the No Action Alternative NT, there would be no change in the frequency of the exceedance of the EC objective under the No Action Alternative LLT; frequency of exceedance would be 2% for both conditions (Appendix H, Table EC-10).

For the entire period modeled, there would be no exceedance of the 1,000 µmhos/cm EC objective at the Jones pumping plant under existing conditions, and the No Action Alternative NT and LLT (Appendix H, Table EC-10). Thus, there would be no adverse effect to the agricultural beneficial uses in the SWP/CVP Export Service AreasExport Service Areas using water pumped at this location under the No Action Alternative LLT.

Average EC levels for the entire period modeled would decrease at the Banks pumping plant by 7% and at the Jones pumping plant by 5% under the No Action Alternative LLT, relative to existing conditions. During the drought period modeled, average EC levels would decrease at the Banks pumping plant by 6% and at the Jones pumping plant by 5% under the No Action Alternative LLT, relative to existing conditions. Consequently, in the long-term, water delivered to the SWP/CVP Export Service Areas through these south Delta pumps would be of similar or slightly better quality with regard to EC under the No Action Alternative LLT, relative to existing conditions. Relative to the No Action Alternative NT, average EC levels would increase by 1% at the Banks pumping plant and 2% at the Jones pumping plant for the entire period modeled and the drought period modeled. (Appendix H, Table EC-11) Based on the long-term decreases in EC levels that would occur at the Banks and Jones pumping plants, the No Action Alternative LLT would not cause long-term degradation of EC levels in the SWP/CVP Export Service Areas, relative to existing conditions.

Commensurate with the EC decrease in exported waters, an improvement in lower San Joaquin River EC levels would be expected since EC in the lower San Joaquin River is, in part, related to irrigation water deliveries from the Delta. While the magnitude of this expected lower San Joaquin River improvement in EC is difficult to predict, the relative decrease in overall loading of EC-elevating constituents to the SWP/CVP Export Service Areas would likely alleviate or lessen any expected increase in EC at Vernalis related to decreased annual average San Joaquin River flows (see discussion of Upstream of the Delta).

The export area of the Delta is listed on the state's CWA Section 303(d) list as impaired due to elevated EC. The No Action Alternative LLT would result in lower average EC levels relative to existing conditions and, thus, would not contribute to additional impairment related to elevated EC in the SWP/CVP Export Service Areas waters. Relative to the No Action Alternative NT, there would be an increase of 1–2% in EC at the export pumps, which could contribute to relative additional impairment in the SWP/CVP Export Service Areas waters.

CEQA Conclusion: Relative to existing conditions, the No Action Alternative LLT would not result in any substantial increases in long-term average EC levels upstream of the Delta or in the SWP/CVP

Export Service Areas. In the Plan Area, the No Action Alternative LLT would result in an increase in the frequency with which Bay-Delta WQCP EC objectives are exceeded in the Sacramento River at Emmaton for the entire period modeled (1976–1991) and during the drought period modeled (1987–1991). Further, long-term average EC levels would increase by 1% for the entire period modeled and 10% during the drought period modeled at Emmaton. The increases in drought period average EC levels that would occur in the Sacramento River at Emmaton would further degrade existing EC levels and thus contribute additionally to adverse effects on the agricultural beneficial use. Because EC is not bioaccumulative, the increases in long-term average EC levels would not directly cause bioaccumulative problems in aquatic life or humans. The western Delta is Clean Water Act section 303(d) listed for elevated EC and the increases in long-term average EC and increased frequency of exceedance of EC objectives that would occur in the Sacramento River at Emmaton could make beneficial use impairment measurably worse. This impact is considered to be potentially significant and unavoidable.

Impact WQ-13: Effects on mercury concentrations resulting from facilities operations and maintenance

[*Note to Lead Agencies: This assessment is in preparation*].

Impact WQ-15: Effects on nitrate concentrations resulting from facilities operations and maintenance

Upstream of the Delta

Substantial point sources of nitrate do not exist upstream of the Delta in the Sacramento River watershed. Non-point sources of nitrate within the Sacramento watersheds are also relatively low, thus resulting in generally low nitrate-N concentrations in the reservoirs and rivers of the watershed. Furthermore, there is no correlation between historical water year average nitrate concentrations and water year average flow in the Sacramento River atFreeport (Nitrate Appendix J Figure 1). Consequently, any modified reservoir operations and subsequent changes in river flows under the No Action LLT, relative to existing conditions and No Action NT, are expected to have negligible, if any, effects on average reservoir and river nitrate-N concentrations in the Sacramento River watershed upstream of the Delta.

In the San Joaquin River watershed, nitrate concentrations are higher than in the Sacramento watershed, owing to use of nitrate based fertilizers throughout the lower watershed. The correlation between historical water year average nitrate concentrations and water year average flow in the San Joaquin River at Vernalis is a weak inverse relationship—that is, generally higher flows result in lower nitrate concentrations, while low flows result in higher nitrate concentrations (linear regression r2=0.49, Nitrate Appendix J Figure 2). Under the No Action Alternative LLT, long-term average flows at Vernalis would decrease an estimated 6% relative to existing conditions and 5% relative to No Action NT (crossreference to Modeling Data Appendix, CALSIM Flow Data for Vernalis). Given these relatively small decreases in flows and the weak correlation between nitrate and flows in the San Joaquin River, it is expected that nitrate concentrations in the San Joaquin River will be minimally affected, if at all, by anticipated changes in flow rates under the No Action Alternative LLT.

Any negligible changes in nitrate-N concentrations that may occur in the water bodies of the affected environment located upstream of the Delta would not be of frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the quality of these water bodies, with regards to nitrate.

Delta

Results of the mixing calculations indicate that under the No Action Alternative LLT, relative to existing conditions and No Action NT, nitrate concentrations throughout the Delta are anticipated to remain low (<1.4 mg/L-N) relative to adopted objectives (Nitrate Appendix J Table 4 and 5). Although changes at specific Delta locations and for specific months may be substantial on a relative basis, the absolute concentration of nitrate in Delta waters would remain low (<1.4 mg/L-N) in relation to the drinking water MCL of 10 mg/L-N, as well as all other thresholds identified in Table XX. Long-term average nitrate concentrations are anticipated to remain below 1 mg/L-N at all 11 assessment locations except the San Joaquin River at Buckley Cove, where long-term average concentrations would be somewhat above 1 mg/L-N. Nevertheless, at this location, long-term average nitrate concentration would be somewhat reduced under the no Action Alternative LLT, relative to existing conditions and the No Action NT. No additional exceedances of the MCL are anticipated at any location (Nitrate Appendix J Table 4). On a monthly average basis and on a long term annual average basis, for all modeled years and for the drought period (1987-1991) only, use of assimilative capacity available under existing conditions and No Action NT, relative to the drinking water MCL of 10 mg/L-N, was low or negligible (i.e., <3%) for all locations and months (Nitrate Appendix J Table 6).

Nitrate concentrations will likely be higher than the modeling results indicate in certain locations, including: (1) in the Sacramento River between Freeport and Mallard Island and other areas in the Delta downstream of Freeport that are influenced by Sacramento River water, the increase becoming greater with increasing distance downstream, due to conversion of ammonia from the SRWTP discharge at Freeport (under existing conditions and No Action Alternative NT only, since upgrades to SRWTP that substantially reduce ammonia concentrations in the Sacramento River downstream of Freeport are assumed in the LLT; see the Ammonia section of this chapter for further discussion); (2) immediately downstream of wastewater treatment plants that practice nitrification, but not denitrification (e.g., City of Rio Vista Beach WWTF, Town of Discovery Bay WWTF, City of Stockton RWCF).

The effect of (1) (above) is expected to be small, on the order of 1 mg/L-N nitrate as N or less in the existing conditions and No Action Alternative NT. This is because the existing increase appears to be from approximately 0.1 mg/L-N to approximately 0.4-0.5 mg/L-N over this reach, due to approximately a 1:1 conversion of ammonia-N to nitrate-N (CVWQCB 2010:32). Because this nitrate is assumed not to be generated under the No Action Alternative LLT, average concentrations would be expected to decrease under the No Action Alternative LLT in this reach of the Sacramento River relative to existing conditions and the No Action Alternative NT. Regarding number (2) (above), for all such facilities in the Delta, the Regional Water Boards have issued NPDES permits that allow discharge of wastewater containing nitrate into the Delta, and under these permits, the State has determined that no beneficial uses are adversely affected by the discharge, and that the discharger's use of available assimilative capacity of the water body is acceptable. When dilution is necessary in order for the discharge to be in compliance with the Basin Plans (which incorporate the 10 mg/L-N MCL by reference), not all of the assimilative capacity of the receiving water is granted to the discharger. Thus, limited decreases in flows are not anticipated to result in systemic exceedances of the MCLs by these POTWs. Furthermore, NPDES permits are renewed on a 5-year basis, and thus, if under changes in flows, dilution was no longer sufficient to maintain nitrate below the MCL in the receiving water, the NPDES permit renewal process would address such cases.

Therefore, any increases in nitrate-N concentrations that may occur at certain locations within the Delta would not be of frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the water quality at these locations, with regards to nitrate.

SWP/CVP Export Service Areas

Assessment of effects of nitrate in the SWP and CVP Export Service Areas is based on effects on nitrate-N at the Banks and Jones pumping plants.

Results of the mixing calculations indicate that under the No Action Alternative LLT, relative to existing conditions and No Action NT, long-term average nitrate concentrations at Banks and Jones pumping plants are anticipated to change negligibly (Nitrate Appendix J Table 4 and 5). No additional exceedances of the MCL are anticipated (Nitrate Appendix J Table 4). On a monthly average basis and on a long term annual average basis, for all modeled years and for the drought period (1987-1991) only, use of assimilative capacity available under existing conditions and No Action NT relative to the MCL was negligible (i.e., <4%) for both Banks and Jones pumping plants (Nitrate Appendix J Table 6). As discussed above in the Delta region, nitrate-N concentrations would be higher than indicated in the mixing modeling results for areas receiving Sacramento River water, including Banks and Jones pumping plants, downstream of the SRWTP discharge at Freeport in the existing conditions and No Action NT (by < 1 mg/L-N), due to conversion of ammonia to nitrate within the Delta. For the No Action LLT, full nitrification/denitrification of the SRWTP discharge is assumed, and thus this increase would not be present. Hence, long-term average nitrate-N concentrations would be expected to decrease under the No Action LLT, relative to existing conditions and No Action NT.

Any short-term, negligible increases in nitrate-N concentrations that may occur in water exported via Banks and Jones pumping plants are not expected to result in adverse effects to beneficial uses of exported water or substantially degrade the quality of exported water, with regards to nitrate.

***CEQA Conclusion*:** There would be no substantial, long-term increase in nitrate-N concentrations in the rivers and reservoirs upstream of the Delta, in the Delta Region, or the waters exported to the CVP and SWP service areas under the No Action Alternative LLT relative to existing conditions. As such, this alternative is not expected to cause additional exceedance of applicable water quality objectives/criteria by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. Because nitrate concentrations are not expected to increase substantially, no long-term water quality degradation is expected to occur and, thus, no adverse effects to beneficial uses would occur. Nitrate is not 303(d) listed within the affected environment and thus any minor increases than may occur in some areas would not make any existing nitrate-related impairment measurably worse because no such impairments currently exist. Because nitrate is not bioaccumulative, minor increases that may occur in some areas would not bioaccumulate to greater levels in aquatic organisms that would, in turn, pose substantial health risks to fish, wildlife, or humans. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-17: Effects on organic carbon concentrations resulting from facilities operations and maintenance

Upstream of the Delta

Under the No Action Alternative LLT, greater water demands will alter the magnitude and timing of reservoir releases upstream of the Delta, relative to existing conditions and No Action Alternative NT. While greater water demands under the No Action Alternative LLT would alter the magnitude and timing of reservoir releases north, south and east of the Delta, these activities would have no substantial effect on the various watershed sources of DOC. Moreover, long-term average flow and DOC at Sacramento River at Hood and San Joaquin River at Vernalis are poorly correlated; therefore, changes in river flows would not be expected to cause a substantial long-term change in DOC concentrations upstream of the Delta. Consequently, long-term average DOC concentrations under the No Action Alternative LLT would not be expected to change by frequency, magnitude and geographic extent, relative to existing conditions and the No Action Alternative NT, and thus, would not adversely affect the MUN beneficial use, or any other beneficial uses, in water bodies of the affected environment located upstream of the Delta.

Delta

Relative to existing conditions, the No Action Alternative LLT would result in mostly minor changes (i.e., up to 4% increases and 6% decreases) in long-term average DOC concentrations at all Delta assessment locations. Increases in long-term average DOC concentrations for the 16-year (1976–1991) hydrologic period modeled would not be greater than 0.1 mg/L, with the largest predicted change occurring at Rock Slough during the 1987–1991 drought period modeled, where average DOC concentration would be predicted to increase by approximately 4% (Appendix 8K, DOC Table 1). At all 11 assessment locations, modeled long-term average DOC concentrations under the No Action Alternative LLT would exceed 2 mg/L 94–100% of the time. The frequency with which average DOC concentration exceeds the 3 mg/L threshold would change only slightly, with exception to predicted changes at both the Banks and Jones pumping plants. At the Banks pumping plant, the frequency with which average DOC concentration would exceed 3 mg/L would increase from 64% under existing conditions to 71% under the No Action Alternative LLT (an increase from 57% to 75% during the drought year period of 1987–1991). At the Jones pumping plant, the frequency that long-term average DOC concentration would exceed 3 mg/L would increase from 71% under existing conditions to 80% under the No Action Alternative LLT (an increase from 72% to 90% for the drought period modeled). In contrast, however, the relative frequency long-term average DOC concentrations would exceed 4 mg/L at the Banks and Jones pumping plants would be small. At the Banks pumping plant, the frequency long-term average DOC concentrations would exceed 4 mg/L would increase from 33% under existing conditions to 35% under the No Action Alternative LLT (an increase from 42% to 43% for the drought period), while at the Jones pumping plant the modeled exceedance frequency would rise from 26% to 28% (with no predicted change in frequency of exceedance for the drought period). Trends in concentration threshold exceedances at the other assessment locations would follow that described for the Banks and Jones pumping plants, but the overall magnitude of threshold exceedance change would be less. While the No Action Alternative LLT would generally lead to slightly higher long-term average DOC concentration in the western and southern Delta, the predicted change would not be expected to be of magnitude that would adversely affect MUN beneficial uses, or any other beneficial use, particularly when considering the relatively small change in long-term annual average concentration.

Relative to No Action Alternative NT, the No Action Alternative LLT would generally result in a similar magnitude of change to that discussed for the comparison to existing conditions. Long-term average DOC concentrations would change no greater than 0.1 mg/L, with the greatest relative change (i.e., 4%) occurring at Rock Slough (Appendix 8K, DOC Table 1). Modeled exceedance of the 3 mg/L threshold would be greatest for the Banks and Jones pumping plants, where exceedance frequency at Banks would increase from 66% under No Action Alternative NT to 71% under the No Action Alternative LLT (65% to 75% for the drought period), and at Jones would increase from 76% under No Action Alternative NT to 80% under the No Action Alternative LLT (80% to 90% for the drought period). However, unlike comparison to the existing condition, the greatest change in exceedance of the 4 mg/L threshold would occur at Buckley Cove, where the frequency of exceedance would increase from 23% under No Action Alternative NT to 27% under the No Action Alternative LLT (an increase from 37% to 42% for the drought period). While the No Action Alternative LLT would generally lead to slightly higher long-term average DOC concentrations at some Delta assessment locations, the predicted change would not be expected to be of sufficient magnitude to adversely affect the MUN beneficial use, or any other beneficial use, of the Delta.

SWP/CVP Export Service Areas

With respect to the potential for effects resulting from No Action Alternative LLT induced changes on long-term average DOC concentrations in the water exported via the Banks and Jones pumping plants, long-term average DOC concentrations would increase only slightly. Under the No Action Alternative LLT, long-term average DOC concentrations at the Banks and Jones pumping plants would increase by as much as 3% relative to existing conditions and 2% relative to No Action Alternative NT (Appendix 8K, DOC Table 1). A greater frequency of exports greater than 3 and 4 mg/L would be predicted to occur at both Banks and Jones pumping plants, as previously discussed for the Delta, although the increased frequency of 4 mg/L would be comparatively small (see Delta discussion above). As previously stated, the predicted change in long-term average DOC concentrations relative to existing or No Action Alternative NT conditions would not be expected to be of sufficient magnitude to adversely affect the MUN beneficial use, or any other beneficial use, within the SWP and CVP Service Area.

Maintenance of SWP and CVP facilities under the No Action Alternative LLT would not be expected to create new sources of DOC or contribute towards a substantial change in existing sources of DOC in the affected environment. Maintenance activities would not be expected to cause any substantial change in long-term average DOC concentrations such that the MUN beneficial use, or any other beneficial use, would be adversely affected anywhere in the affected environment.

CEQA Conclusion: Relative to existing conditions, the No Action Alternative LLT would not result in any substantial change in long-term average DOC concentration upstream of the Delta or result in substantial increase in the frequency with which long-term average DOC concentrations exceeds 2, 3, or 4 mg/L levels at the 11 assessment locations analyzed for the Delta. Modeled long-term average DOC concentrations would increase by no more than 0.1 mg/L at any single Delta assessment location (i.e., ≤4% relative increase). The increases in long-term average DOC concentration that could occur within the Delta would not be of sufficient magnitude to adversely affect the MUN beneficial use, or any other beneficial uses, of Delta waters or waters of the SWP and CVP Service Area. Because DOC is not bioaccumulative, the increases in long-term average DOC concentrations would not directly cause bioaccumulative problems in aquatic life or humans. Finally, DOC is not causing beneficial use impairments and thus is not 303(d) listed for any water body within the affected environment. Thus, the increases in long-term average DOC that could occur at various locations would not make any beneficial use impairment measurably worse. Because long-term average DOC concentrations would not be expected to increase substantially, no long-term water quality degradation with respect to DOC would be expected to occur and, thus, no significant impacts on beneficial uses would occur. This impact would be less than significant. No mitigation is required.

Additional Conservation Measures

Under the No Action Alternative, existing policies and programs would continue and CM2–CM22 would not be implemented.

Impact WQ-19: Effects on pathogens resulting from facilities operations and maintenance

Upstream of the Delta

Under the No Action Alternative LLT, the only pathogen sources expected to change in the watersheds upstream of the Delta relative to existing conditions would be associated with population growth, i.e., increased municipal wastewater discharges and development contributing to increased urban runoff.

Increased municipal wastewater discharges resulting from future population growth would not be expected to measurably increase pathogen concentrations in receiving waters due to state and federal water quality regulations requiring disinfection of effluent discharges and the state's implementation of Title 22 filtration requirements for many wastewater dischargers in the Sacramento River and San Joaquin River watersheds.

Pathogen loading from urban areas would generally occur in association with both dry and wet weather runoff from urban landscapes. Municipal stormwater regulations and permits have become increasingly stringent in recent years, and such further regulation of urban stormwater runoff is expected to continue in the future. Municipalities may implement best management practices (BMPs) for reducing pollutant loadings from urban runoff, particularly in response to NPDES stormwater-related regulations requiring reduction of pollutant loading in urban runoff. The ability of these BMPs to consistently reduce pathogen loadings and the extent of future implementation is uncertain, but would be expected to improve as new technologies are continually tested and implemented. Also, some of the urbanization may occur on lands used by other pathogens sources, such as grazing lands, resulting in a change in pathogen source, but not necessarily an increase (and possibly a decrease) in pathogen loading.

Pathogen concentrations in the Sacramento and San Joaquin Rivers have a minimal relationship to flow rate in these rivers, although most of the high concentrations observed have been during the wet months (Tetra Tech 2007). Further, urban runoff contributions during the dry season would be expected to be a relatively small fraction of the rivers' total flow rates. During wet weather events, when urban runoff contributions would be higher, the flows in the rivers also would be higher. Given the small magnitude of urban runoff contributions relative to the magnitude of river flows, that pathogen concentrations in the rivers have a minimal relationship to river flow rate, and the expected reduced pollutant loadings in response to NPDES stormwater-related regulations, river flow rate and reservoir storage reductions that would occur under the No Action Alternative LLT, relative to existing conditions, would not be expected to result in a substantial adverse change in pathogen concentrations in the reservoirs and rivers upstream of the Delta. As such, the No Action Alternative LLT would not be expected to substantially increase the frequency with which applicable

Basin Plan objectives or U.S. EPA-recommended pathogen criteria would be exceeded in water bodies of the affected environment located upstream of the Delta or substantially degrade the quality of these water bodies, with regard to pathogens.

For the same reasons given above, the No Action Alternative LLT is expected to have minimal effects on pathogen concentrations and water quality objective/criteria exceedances in the reservoirs and rivers upstream of the Delta, relative to the No Action Alternative NT.

Delta

The *Conceptual Model for Pathogens and Pathogen Indicators in the Central Valley and Sacramento-San Joaquin Delta* (Pathogens Conceptual Model; Tetra Tech 2007) provides a comprehensive evaluation of factors affecting pathogen levels in the Delta. The Pathogens Conceptual Model characterizes relative pathogen contributions to the Delta from the Sacramento and San Joaquin Rivers and various pathogen sources, including wastewater discharges and urban runoff. Contributions from the San Francisco Bay to the Delta are not addressed. The Pathogens Conceptual Model is based on a database compiled by the Central Valley Drinking Water Policy Group in 2004–2005, supplemented with data from Natomas East Main Drainage Canal Studies, North Bay Aqueduct sampling, and the USGS. Data for multiple sites in the Sacramento River and San Joaquin River watersheds, and in the Delta were compiled. Indicator species evaluated include fecal coliforms, total coliforms, and *E. coli*. Because of its availability, *Cryptosporidium* and *Giardia* data for the Sacramento River also were evaluated. Key results of the data evaluation are:

Total coliform

In the Sacramento Valley, the highest total coliform concentrations (>10,0000 MPN/100 ml) were located near urban areas.

Similarly high total coliform concentrations were not observed in the San Joaquin Valley, because reported results were capped at about 2,400 MPN/100 ml, though a large number of results were reported as being greater than this value.

The data should not to be interpreted to conclude that Sacramento River has higher total coliform concentrations; rather, the "appearance" of the lower total coliform concentrations in the San Joaquin Valley is attributed to a lower upper limit of reporting (2,400 MPN/100 ml versus 10,000 MPN/100 ml).

E. coli

Comparably high concentrations observed in the Sacramento River and San Joaquin River watersheds for waters affected by urban environments and intensive agriculture.

The highest concentrations in the San Joaquin River were not at the most downstream location monitored, but rather at an intermediate location near Hills Ferry.

E. coli concentrations in the Delta were somewhat higher than in the San Joaquin River and Sacramento River, indicating the importance of in-Delta sources and influence of distance of pathogen source on concentrations at a particular location in the receiving waters.

Temporal (seasonal) trends were weak, however, the highest concentrations in the Sacramento River were observed during the wet months and the lowest concentrations were observed in July and August.

Fecal coliform

Limited data from which to make comparisons/observations.

Cryptosporidum and Giardia

Data available only for the Sacramento River.

Often not detected and when detected, concentrations typically less than 1 organism per liter.

There may be natural/artificial barriers/processes that limit transport to water. Significant die off of those that reach the water contribute to the low frequency of detection.

The Pathogens Conceptual Model found that coliform indicators vary by orders of magnitudes over small distances and short time-scales. Concentrations appear to be more closely related to what happens in the proximity of a sampling station, rather than what happens in the larger watershed where significant travel time and concomitant pathogen die-off can occur. Sites in the Delta close to urban discharges had elevated concentrations of coliform organisms. The highest total coliform and *E. coli* concentrations were observed in the discharge from the Natomas East Main Drainage Canal and several stations near sloughs, indicating the relative influence of urban and wildlife pathogen sources on receiving water concentrations.

The effects of the No Action Alternative LLT relative to existing conditions would be changes in the relative percentage of water throughout the Delta being comprised of various source waters (i.e., water from the Sacramento River, San Joaquin River, Bay water, eastside tributaries, and agricultural return flow), due to potential changes in inflows particularly from the Sacramento River watershed due to increased water demands and somewhat modified SWP and CVP operations. However, it is expected there would be no substantial change in Delta pathogen concentrations in response to a shift in the Delta source water percentages under this alternative or substantial degradation of these water bodies, with regard to pathogens. This conclusion is based on the Pathogens Conceptual Model, which found that pathogen sources in close proximity to a Delta site appear to have the greatest influence on pathogen levels at the site, rather than the primary source(s) of water to the site. In-Delta potential pathogen sources, including water-based recreation, tidal habitat, wildlife, and livestock-related uses, would continue under this alternative.

For the same reasons given above, the No Action Alternative LLT is expected to have minimal effects on pathogen concentrations in the Delta relative to the No Action Alternative NT.

SWP/CVP Export Service Areas

The No Action Alternative LLT is not expected to result in substantial changes in pathogen levels in Delta waters, relative to existing conditions and the No Action Alternative NT. As such, there is not expected to be substantial, if even measurable, changes in pathogen concentrations in the SWP/CVP Export Service Areas waters under the No Action Alternative LLT, relative to existing conditions and the No Action Alternative NT.

CEQA Conclusion: There would be no substantial, and likely no measurable, long-term increase in pathogen concentrations in the rivers and reservoirs upstream of the Delta, in the PlanArea, or the SWP/CVP Export Service Areas waters under the No Action Alternative LLT relative to existing conditions. As such, this alternative is not expected to cause additional exceedance of applicable water quality objectives by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. Because pathogen concentrations are not expected to increase substantially, no long-term water quality degradation for pathogens is expected to occur and, thus, no adverse effects on beneficial uses would occur. The San Joaquin River in the Stockton Deep Water Ship Channel is Clean Water Act section 303(d) listed for pathogens. Because no measurable increase in Deep Water Ship Channel pathogen concentrations are expected to occur on a long-term basis, further degradation and impairment of this area is not expected to occur. Finally, pathogens are not bioaccumulative constituents. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-21: Effects on pesticide concentrations resulting from facilities operations and maintenance

Upstream of the Delta

Pyrethroid and OP insecticides are applied to agricultural fields, orchards, row crops, and confined animal facilities on an annual basis, with peaks in agricultural application during the winter dormant season (January–February) and during field cropping in the spring and summer. Applications of diuron occur year-round, but the majority of diuron is applied to road rights-of-way as a pre-emergent and early post emergent weed treatment during the late fall and early winter (Green and Young, 2006). Pyrethroid insecticides and urban use herbicides are additionally applied around urban and residential structures and landscapes on an annual basis. These applications throughout the upstream watershed represent the source and potential pool of these pesticides that may enter the rivers upstream of the Delta by way of surface runoff and/or drift. Principal factors contributing to pesticide loading in the Sacramento River watershed include the amount of pesticide used and amount of precipitation (Guo et al., 2004). Although urban dry weather runoff occurs, this is generally believed to be less significant source of pesticides to main stem receiving waters, but for pyrethroids a recent study concluded that municipal wastewater treatment plants in Sacramento and Stockton represent a continuous year-round source of pyrethroids to the lower Sacramento and San Joaquin River's (Weston and Lydy, 2010).

Pesticide-related toxicity has historically been observed throughout the affected environment regardless of season or water year type; however, toxicity is generally observed with increased incidence during spring and summer months of April to June, coincident with the peak in irrigated agriculture in the Sacramento and San Joaquin Valleys, as well as the winter rainy season, particularly December through February, coincident with urban and agricultural stormwater runoff and the orchard dormant spraying season (Fox and Archibald 1997). Although OP insecticide incidence and related toxicity can be observed throughout the year, diazinon is most frequently observed during the winter months and chlorpyrifos is most frequently observed in the summer irrigation months (Central Valley Regional Water Quality Control Board 2007). These seasonal trends coincide with their use, where diazinon is principally used as an orchard dormant season spray, and chlorpyrifos is primarily used on crops during the summer.

Application of diuron peaks in the late fall and early winter. Coincidently, diuron is found most frequently in surface waters during the winter precipitation and runoff months of January through March (Miller et al. 2005), although diruon can be found much less frequently in surface waters throughout the year (Johnson et al., 2010).

Monitoring for pyrethroid insecticides in main-stem rivers is limited and detections are rather few. With the replacement of many traditionally OP related uses, however, it is conservatively assumed that pyrethroid incidence and associated toxicity could ultimately take a pattern of seasonality similar to that of the chlorpyrifos or diazinon.

In comparison to the Valley floor, relatively small amounts of pesticides are used in watersheds upstream of project reservoirs. Water released from reservoirs flow through urban and agricultural areas at which point these waters may acquire a burden of pesticide from agricultural or urban sourced discharges. These discharges with their potential burden of pesticides are effectively diluted by reservoir water. Under the No Action Alternative, no activity of the SWP or CVP would substantially drive a change in pesticide use, and thus pesticide sources would remain unaffected. Nevertheless, changes in the timing and magnitude of reservoir releases could have an effect on available dilution capacity along river segments such as the Sacramento, Feather, American, and San Joaquin Rivers.

Under the No Action Alternative LLT, winter (November–March) and summer (April–October) season average flow rates on the Sacramento River at Freeport, American River at Nimbus, Feather River at Thermalito and the San Joaquin River at Vernalis would change relative to existing conditions and No Action Alternative NT. Averaged over the entire period of record,seasonal mean flow rates would largely remain unchanged on the Sacramento River and Feather Rivers (Appendix 8L, Seasonal average flows Tables 1-4). Summer average flow rates on the American River would decrease by 16% relative to existing conditions and 12% relative to No Action Alternative NT. During the winter months, however, average flow rates would increase by as much as 9% on the American River. Similarly, summer average flow rates on the San Joaquin River would decrease by 12% relative to existing conditions and 11% relative to No Action Alternative NT, while winter average flow rates would increase slightly.

As previously stated, historically chlorpyrifos is used in greater amounts in agriculture in the summer, and consequently observed in surface waters with greater frequency in the summer, while diazinon and diuron are used and observed in surface water with greater frequency in the winter. While flow reductions in the summer on the American River would not coincide with urban stormwater discharges, summer flow reductions on the San Joaquin River would correspond to the agricultural irrigation season. However, summer average flow reductions of up to 12%, relative to existing conditions, are not considered of sufficient magnitude to substantially increase in-river concentrations or alter the long-term risk of pesticide-related effects on aquatic life beneficial uses.

Delta

Sources of diuron, OP and pyrethroid insecticides to the Plan Area include direct input of surface runoff from in-Delta agriculture and Delta urbanized areas as well inputs from rivers upstream of the Delta. Similar to Upstream of the Delta, CVP/SWP operations would not affect these sources.

Studies documenting pesticide associated toxicity in the Delta demonstrate the dynamic nature of pesticide input. Pesticide loads entering the Delta, but originating outside of the Delta, do so typically in pulses and particularly after significant precipitation induced surface runoff events (Kuivilla and Foe 1995). Through the greater hydraulic capacity of the Delta, and through tidal mixing, these pulses become diluted and spread about the Delta. Although it is difficult to definitively conclude that either the Sacramento River or San Joaquin River is a consistently dominant source of pesticide, a compilation of Delta diazinon and chlorpyrifos data suggest that these two OP insecticides have both been more frequently observed in the San Joaquin River, and at concentrations more frequently exceeding OP specific aquatic life criteria (Central Valley Regional Water Quality Control Board 2006).

No similar observation as to incidence frequency can be made regarding pyrethroid insecticides, primarily owing to a dearth of monitoring data. Pyrethroid insecticides have been observed in Delta waterways, but there is little evidence supporting any particular geographic or seasonal trend (Werner et al, 2010). Unlike that for chlorpyrifos and diazionon, data for pyrethroids are insufficient to determine the relative loading from particular source waters.

Diuron has been detected in the Delta throughout the year, but with greater magnitude and frequency during the winter storm season. Unlike that for chlorpyrifos and diazionon, data for diuron are insufficient to determine the relative loading from particular source waters.

Granting the assessment challenges imposed by data limitations, there does appear sufficient information to suggest that the San Joaquin River, in comparison to the Sacramento River, is a greater contributor of OP insecticides in terms of greater frequency of incidence and presence at concentrations exceeding water quality benchmarks. Although data is insufficient to make similar observations pertaining to diuron, trends in pyrethroid use suggest that pyrethroid insecticides may in the near future reflect the historic trends of OP insecticides, namely that of relative frequency, magnitude, seasonality and geographic distribution. Based on these general observations, this assessment utilizes source water fingerprinting to make qualitative judgments as to increased risk of pesticide related aquatic life toxicity and judgments as to the possibility of associated long-term degradation to water quality.

Percent change in monthly average source water fraction were evaluated for the modeled 16-year (1976–1991) hydrologic period and a representative drought period (1987–1991), with special attention given to changes in San Joaquin River, Sacramento River and Delta Agriculture sources water fractions. For the No Action Alternative LLT, San Joaquin River fractions would not increase more than 10% at any of the 11 modeled assessment locations, with exception to Jones pumping plant during the modeled drought period, where San Joaquin River fraction would increase12–14% in October and November relative to existing conditions, yet would continue to represent less than 43% of the total source water volume (Appendix 8D, Source Water Fingerprinting). Similarly, Sacramento River fractions would not increase more than 10% at any of the 11 modeled assessment locations, with exception to Buckley Cove, where Sacramento fractions would increase as much as 23–28% in October and November of the modeled drought period relative to No Action Alternative NT. However, these large fractional increases in Sacramento River occur through near equal replacement of San Joaquin River water and, as such, would likely represent an overall decrease in risk of pesticide-related toxicity to aquatic life. There would be no modeled increases in Delta agricultural fractions greater than 2%.

These modeled changes in the source water fractions of Sacramento, San Joaquin and Delta agriculture water are not of sufficient magnitude to substantially alter the long-term risk of pesticide-related toxicity to aquatic life within the Delta, nor would such changes result in adverse pesticide-related effects on any other beneficial uses of Delta waters.

SWP/CVP Export Service Areas

Assessment of effects in SWP and CVP Export Service Areas is based on effects seen in the Delta at the Banks and Jones pumping plants. Under the No Action Alternative LLT, Sacramento, San Joaquin and in-Delta Agricultural source water fractions at Banks would not increase more than 5% in any month relative to existing conditions and No Action Alternative NT (Appendix 8D, Source Water Fingerprinting). At Jones during the modeled drought period, San Joaquin River source water fractions would increase by as much as 12–14% in October and November relative to existing conditions, yet would continue to represent less than 43% of the total source water volume. These modeled changes in the source water fractions of Sacramento, San Joaquin and Delta agriculture water are not of sufficient magnitude to substantially alter the long-term risk of pesticide-related toxicity to aquatic life beneficial uses, or any other beneficial uses, in water bodies of the SWP and CVP service area.

CEQA Conclusion: Relative to existing conditions, the No Action Alternative LLT would not result in any substantial change in long-term average pesticide concentration or result in substantial increase in the anticipated frequency with which long-term average pesticide concentrations would exceed aquatic life toxicity thresholds or other beneficial use effect thresholds upstream of the Delta, at the 11 assessment locations analyzed for the Delta, or the SWP and CVP service area. Numerous pesticides are currently used throughout the affected environment, and while some of these pesticides may be bioaccumulative, those present-use pesticides for which there is sufficient evidence for their presence in waters affected by SWP and CVP operations (i.e., diazinon, chlorpyrifos, diuron, and pyrethroids) are not considered bioaccumulative, and thus changes in their concentrations would not directly cause bioaccumulative problems in aquatic life or humans. Furthermore, while there are numerous 303(d) listings throughout the affected environment that name pesticides as the cause for beneficial use impairment, the modeled changes in upstream river flows and Delta source water fractions would not be expected to make any of these beneficial use impairments measurably worse. Because long-term average pesticide concentrations are not expected to increase substantially, no long-term water quality degradation with respect to pesticides is expected to occur and, thus, no adverse effects on beneficial uses would occur. This impact is considered to be less than significant. No mitigation is required.

Additional Conservation Measures

Under the No Action Alternative, existing policies and programs would be continued and none of the CM2–CM22 associated with the action alternatives would be implemented.

Impact WQ-23: Effects on phosphorus concentrations resulting from facilities operations and maintenance

Upstream of the Delta

A conceptual model of nutrients in the Delta stated that: "previous attempts to relate concentration data to flow data in the Central Valley and Delta showed little correlation between the two variables (Tetra Tech, 2006, Conceptual Model for Organic Carbon in the Central Valley). One possible reason is that the Central Valley and Delta system is a highly managed system with flows controlled by major reservoirs on most rivers" (Tetra Tech 2006:41 to 4-2). Attempts made in the Nitrate section of this chapter also showed weak correlation between nitrate and flows for major source waters to the Delta. Correlations between average dissolved orthophosphate concentrations and average flows in the San Joaquin and Sacramento Rivers were derived for this analysis Figure 61 and Figure 62 (). As expected, neither correlation is very strong, although over the large range in flows for the Sacramento River, the correlation is stronger than for the San Joaquin River. However, over smaller changes in flows, neither correlation can function as a predictor of phosphorus concentrations because the variability in the data over small to medium ranges of flows (i.e., < 10,000 CFS) is large.

Because phosphorus loading to waters upstream of the Delta is not anticipated to change, and because changes in flows do not necessarily result in changes in concentrations or loading of phosphorus to these water bodies, substantial changes in phosphorus concentration are not anticipated for the No Action Alternative LLT, relative to existing conditions or No Action NT. Any negligible changes in phosphorus concentrations that may occur in the water bodies of the affected environment located upstream of the Delta would not be of frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the quality of these water bodies, with regards to phosphorus.

Delta

Because phosphorus concentrations in the major source waters to the Delta are similar for much of the year, phosphorus concentrations in the Delta are not anticipated to change substantially on a long term-average basis. Phosphorus concentrations may increase during January through March at locations where the source fraction of San Joaquin River water increases, due to the higher concentration of phosphorus in the San Joaquin River during these months compared to Sacramento River water or San Francisco Bay water. Based on the DSM2 fingerprinting results (see Appendix D), together with source water concentrations show in Figure 60, the magnitude of increases during these months may range from negligible up to approximately 0.05 mg/L. However, there are no state or federal objectives/criteria for phosphorus and thus any increases would not cause exceedances of objectives/criteria. Because algal growth rates are limited by availability of light in the Delta, increases in phosphorus levels that may occur at some locations and times within the Delta would be expected to have little effect on primary productivity in the Delta. Moreover, such increases in concentrations would not be anticipated to be of frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the water quality at these locations, with regards to phosphorus.

SWP/CVP Export Service Areas

Assessment of effects of phosphorus in the SWP and CVP Export Service Areas is based on effects on phosphorus at the Banks and Jones pumping plants.

As noted in the Delta Region section above, phosphorus concentrations in the Delta (including Banks and Jones pumping plants) are not anticipated to change substantially on a long term-average basis. During January through March, phosphorus concentrations may increase as a result of more San Joaquin River water reaching Banks and Jones pumping plants and the higher concentration of phosphorus in the San Joaquin River. However, based on the DSM2 fingerprinting results (see Appendix D), together with source water concentrations show in Figure 60, the magnitude of this increase is expected to be negligible (<0.01 mg/L-P). Additionally, there are no state or federal objectives for phosphorus. Moreover, given the many factors that contribute to potential algal blooms in the SWP and CVP canals within the Export Service Area, and the lack of studies that have shown a direct relationship between nutrient concentrations in the canals and reservoirs and problematic algal blooms in these water bodies, there is no basis to conclude that any seasonal increases in phosphorus concentrations at the levels expected under this alternative, should they occur, would increase the potential for problem algal blooms in the SWP and CVP Export Service Area.

Any increases in phosphorus concentrations that may occur in water exported via Banks and Jones pumping plants are not expected to result in adverse effects to beneficial uses of exported water or substantially degrade the quality of exported water, with regards to phosphorus.

***CEQA Conclusion*:** There would be no substantial, long-term increase in phosphorus concentrations in the rivers and reservoirs upstream of the Delta, in the Delta Region, or the waters exported to the CVP and SWP service areas under the No Action Alternative LLT relative to existing conditions. As such, this alternative is not expected to cause additional exceedance of applicable water quality objectives/criteria by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. Because phosphorus concentrations are not expected to increase substantially, no long-term water quality degradation is expected to occur and, thus, no adverse effects to beneficial uses would occur. Phosphorus is not 303(d) listed within the affected environment and thus any minor increases than may occur in some areas would not make any existing phosphorus-related impairment measurably worse because no such impairments currently exist. Because phosphorus is not bioaccumulative, minor increases that may occur in some areas would not bioaccumulate to greater levels in aquatic organisms that would, in turn, pose substantial health risks to fish, wildlife, or humans. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-25: Effects on selenium concentrations resulting from facilities operations and maintenance

[*Note to Lead Agencies: This assessment is in preparation*].

Impact WQ-27: Effects on trace metal concentrations resulting from facilities operations and maintenance

Upstream of the Delta

Relative to existing conditions, under the No Action Alternative LLT sources of trace metals would not be expected to change substantially with exception to sources related to population growth, such as increased municipal wastewater discharges and development contributing to increased urban runoff. Facility operations could have an effect on these sources if concentrations of dissolved metals were closely correlated to river flow, suggesting that changes in river flow, and the related capacity to dilute these sources, could ultimately have a substantial effect on long-term metals concentrations.

On the Sacramento River, available dissolved trace metals data and river flow at Freeport are poorly associated (Appendix 8N, Figure 1 and 2). Similarly, dissolved copper, iron, and manganese concentrations on the San Joaquin River at Vernalis are poorly associated. While there is an insufficient number of data for the other trace metals to observe trends at Vernalis, it is reasonable to assume that these metals similarly show poor association to San Joaquin River flow, as shown for the corresponding dissolved metals on the Sacramento River.

Given the poor association of dissolved trace metal concentrations with flow, river flow rate and reservoir storage reductions that would occur under the No Action Alternative LLT, relative to existing conditions, would not be expected to result in a substantial adverse change in trace metal concentrations in the reservoirs and rivers upstream of the Delta. As such, the No Action Alternative LLT would not be expected to substantially increase the frequency with which applicable Basin Plan objectives or CTR criteria would be exceeded in water bodies of the affected environment located upstream of the Delta or substantially degrade the quality of these water bodies, with regard to trace metals.

For the same reasons given above, the No Action Alternative LLT is expected to have minimal effects on trace metal concentrations and water quality objective/criteria exceedances in the reservoirs and rivers upstream of the Delta, relative to the No Action Alternative NT.

Delta

For metals of primarily aquatic life concern (copper, cadmium, chromium, led, nickel, silver, and zinc), average and 95th percentile trace metal concentrations of the primary source waters to the Delta are very similar, with difference typically not greater than a factor of 2 to 5 (Appendix 8N, Table Metals-1 and 2). For example, average dissolved copper concentrations on the Sacramento River, San Joaquin River, and Bay (Martinez) are 1.7 µg/L, 2.4 µg/L, and 1.7 µg/L, respectively. The 95th percentile dissolved copper concentrations on the Sacramento River, San Joaquin River, and Bay (Martinez) are 3.4 µg/L, 4.5 µg/L, and 2.4 µg/L, respectively. Given this similarity, very large changes in source water fraction would be necessary to effect a relatively small change in trace metal concentration at a particular Delta location. Moreover, average and 95th percentile trace metal concentrations for these primary source waters are all below their respective water quality criteria, including those that are hardness-based without a WER adjustment (Tables M1 and M2). No mixing of these three source waters could result in a metal concentration greater than the highest source water concentration, and given that the average and 95th percentile source water concentrations for copper, cadmium, chromium, led, nickel, silver, and zinc do not exceed their respective criteria, more frequent exceedances of criteria in the Delta would not occur under the operational scenario for this alternative.

For metals of primarily human health and drinking water concern (arsenic, iron, manganese), average and 95th percentile concentrations are also very similar. The arsenic criterion was established to protect human health from the effects of long-term chronic exposure, while secondary maximum contaminant levels for iron and manganese were established as reasonable goals for drinking water quality. The primary source water average concentrations for arsenic, iron, and manganese are below these criteria. No mixing of these three source waters could result in a metal concentration greater than the highest source water concentration, and given that the average water concentrations for arsenic, iron, and manganese do not exceed water quality criteria, more frequent exceedances of drinking water criteria in the Delta would not be expected to occur under this alternative.

Relative to existing conditions, facilities operation under the No Action Alternative LLT would result in negligible change in trace metal concentrations throughout the Delta. The No Action Alternative LLT would not be expected to substantially increase the frequency with which applicable Basin Plan objectives or CTR criteria would be exceeded in the Delta or substantially degrade the quality of water in the Delta, with regard to trace metals.

For the same reasons given above, the No Action Alternative LLT is expected to have minimal effects on trace metal concentrations and water quality objective/criteria exceedances in Delta, relative to the No Action Alternative NT

SWP/CVP Export Service Areas

The No Action Alternative LLT is not expected to result in substantial changes in trace metal concentrations in Delta waters, relative to existing conditions and the No Action Alternative NT. As such, there is not expected to be substantial changes in trace metal concentrations in the SWP/CVP export service area waters, exported from the Delta through the south Delta pumps, under the No Action Alternative LLT, relative to existing conditions and the No Action Alternative NT.

CEQA Conclusion: There would be no substantial long-term increase in trace metal concentrations in the rivers and reservoirs upstream of the Delta, in the Delta Region, or the SWP/CVP export service area waters under the No Action Alternative LLT relative to existing conditions. As such, this alternative is not expected to cause additional exceedance of applicable water quality objectives/criteria by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. Because trace metal concentrations are not expected to increase substantially, no long-term water quality degradation for trace metals is expected to occur and, thus, no adverse effects to beneficial uses would occur. Furthermore, negligible change in long-term trace metal concentrations throughout the affected environment would not be expected to make any existing beneficial use impairments measurably worse. The trace metals discussed in this assessment are not considered bioaccumulative, and thus would not directly cause bioaccumulative problems in aquatic life or humans. This impact is considered to be less than significant. No mitigation is required.

Additional Conservation Measures

Under the No Action Alternative, existing policies and programs would be continued and none of the CM2–CM22 associated with the action alternatives would be implemented.

Impact WQ-29: Effects on TSS and turbidity resulting from facilities operations and maintenance

Upstream of the Delta

TSS concentrations and turbidity levels in rivers upstream of the Delta are affected primarily by: 1) TSS concentrations and turbidity levels of the water released from the upstream reservoirs, 2) erosion occurring within the river channel beds, which is affected by river flow velocity and bank protection, 3) TSS concentrations and turbidity levels of tributary inflows, point-source inputs, and nonpoint runoff as influenced by surrounding land uses; and 4) phytoplankton, zooplankton and other biological material in the water.

The No Action Alternative LLT would alter the magnitude and timing of water releases from reservoirs upstream of the Delta relative to existing conditions, altering downstream river flows relative to existing conditions. With respect to TSS and turbidity, an increase in river flow is generally the concern, as this increases shear stress on the channel, suspending particles resulting in higher TSS concentrations and turbidity levels. Schoellhamer et al. (2007) noted that suspended sediment concentration was more affected by season than flow, with the higher concentrations for a given flow rate occurring during "first flush events" and lower concentrations occurring during spring snowmelt events. Because of such a relationship, the changes in mean monthly average river flows under the No Action Alternative LLT are not expected to cause river TSS concentrations or turbidity levels (highs, lows, typical conditions) to be outside the ranges occurring under existing conditions. Consequently, this alternative is expected to have minimal effect on TSS concentrations and turbidity levels in the reservoirs and rivers upstream of the Delta, relative to existing conditions.

Changes in land use that would occur relative to existing conditions could have minor effects on TSS concentrations and turbidity levels throughout this portion of the affected environment. Site-specific and temporal exceptions may occur due to localized temporary construction activities, dredging activities, development, or other land use changes. These localized actions would generally require agency permits that would regulate and limit both their short-term and long-term effects on TSS concentrations and turbidity levels to less-than-substantial levels.

For the same reasons given above, the No Action Alternative LLT is expected to have minimal effect on TSS concentrations and turbidity levels in reservoirs and rivers upstream of the Delta relative to the No Action Alternative NT.

Delta

TSS concentrations and turbidity levels in Delta waters are affected by TSS concentrations and turbidity levels of the Delta inflows (and associated sediment load). TSS concentrations and turbidity levels within Delta waters also are affected by fluctuation in flows within the channels due to the tides, with sediments depositing as flow velocities and turbulence are low at periods of slack tide, and sediments becoming suspended when flow velocities and turbulence increase when tides are near the maximum. TSS and turbidity variations can also be attributed to phytoplankton, zooplankton and other biological material in the water.

Under the No Action Alternative LLT there would be no project actions implemented within or affecting the Delta region of the affected environment. Any land use changes that may occur under this alternative would not be expected to have permanent, substantial effects on TSS concentrations and turbidity levels of Delta waters, relative to existing conditions. Furthermore, this alternative would not cause the TSS concentrations or turbidity levels in the rivers contributing inflows to the Delta to be outside the ranges occurring under existing conditions. Consequently, this alternative is expected to have minimal effect on TSS concentrations and turbidity levels in the Delta region, relative to existing conditions. As such, any minor TSS and turbidity changes that may occur under the No Action Alternative LLT would not be of sufficient frequency, magnitude, and geographic extent that would result in adverse effects on beneficial uses in the Delta region, or substantially degrade the quality of these water bodies, with regard to TSS and turbidity.

For the same reasons given above, the No Action Alternative LLT is expected to have minimal effect on TSS concentrations and turbidity levels in Delta waters relative to the No Action Alternative NT.

SWP/CVP Export Service Areas

The No Action Alternative LLT is expected to have minimal effect on TSS concentrations and turbidity levels in Delta waters, including water exported at the south Delta pumps, relative to existing conditions and the No Action Alternative NT. As such, the No Action Alternative LLT is expected to have minimal effect on TSS concentrations and turbidity levels in the SWP/CVP Export Service Areas waters relative to existing conditions and the No Action Alternative NT.

***CEQA Conclusion*:** The No Action Alternative LLT would have minimal effect on TSS concentrations and turbidity levels Upstream of the Delta, in the Plan Area, and the SWP/CVP Export Service Areas relative to existing conditions. Therefore, this alternative is not expected to cause additional exceedance of applicable water quality objectives where such objectives are not exceeded under existing conditions. Because TSS concentrations and turbidity levels are not expected to be substantially different from existing conditions, long-term water quality degradation is not expected, and, thus, beneficial uses are not expected to be adversely affected. Finally, TSS and turbidity are neither bioaccumulative nor Clean Water Act section 303(d) listed constituents. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-31: Water quality impacts resulting from construction-related activities

Under the No Action Alternative, existing facilities and operations would be continued and none of the conservation measures CM1–CM22 associated with the BDCP alternatives would be implemented. However, construction activities would occur in the affected environment over time that are not directly associated with the BDCP alternatives (herein termed "non-BDCP" effects). Routine non-BDCP construction activities that may occur for urbanization and infrastructure to accommodate population growth would generally be anticipated to involve relatively dispersed, temporary, and intermittent land disturbances across the affected environment, and no major non-BDCP infrastructure construction projects are identified under the No Action Alternative. Potential construction-related water quality effects associated with non-BDCP activities may include discharges of turbidity/TSS due to the erosion of disturbed soils and associated sedimentation entering surface water bodies or other construction-related wastes (e.g., concrete, asphalt, cleaning agents, paint, and trash). Additionally, the use of heavy earthmoving equipment may result in spills and leakage of oils, gasoline, diesel fuel, and related petroleum contaminants used in the fueling and operation of such construction equipment.

Some construction-related contaminants, such as polycyclic aromatic hydrocarbons (PAHs) that may be in some fuel and oil petroleum byproducts, may be bioaccumulative in aquatic and terrestrial organisms. Construction activities also may disturb areas where bioaccumulative constituents are present in the soil (e.g., mercury, selenium, organochlorine pesticides), or may disturb soils that contain constituents included on the Section 303(d) lists of impaired water bodies in the affected environment. However, intermittent and temporary construction-related activities would not be anticipated to result in contaminant discharges of substantial magnitude or duration to contribute to long-term bioaccumulation processes, or cause measureable long-term degradation such that existing 303(d) impairments would be made discernibly worse or TMDL actions to reduce loading would be adversely affected.

It is assumed that non-BDCP construction activities would be regulated, as necessary, under state and local grading and erosion control regulations, proponent-defined CEQA-NEPA mitigation measures and Best Management Practices (BMPs), and applicable environmental permits such as the State Water Board's NPDES Stormwater General Permit for Stormwater Discharges Associated with Construction and Land Disturbance Activities (Order No. 2009-0009-DWQ/NPDES Permit No. CAS000002), project-specific waste discharge requirements (WDRs) or CWA Section 401 water quality certification from the appropriate Regional Water Board, California Department of Fish and Game (DFG) Streambed Alteration Agreements, and U.S. Army Corps of Engineers (USACE) CWA Section 404 dredge and fill permits. Consequently, relative to the existing conditions, the potential contaminant discharges associated with construction-related activities that may occur under the No Action Alternative LLT would be avoided and minimized upon implementation of BMPs and adherence to permit terms and conditions. Consequently, construction-related activities would not be expected to cause constituent discharges of sufficient magnitude to result in a substantial increased frequency of exceedances of water quality objectives/criteria, or substantially degrade water quality with respect to the constituents of concern, and thus would not adversely affect any beneficial uses in water bodies upstream of the Delta, within the Delta, or in the SWP and CVP service area.

CEQA Conclusion: Construction-related contaminant discharges would be temporary and intermittent in nature and would involve negligible, if any, discharges of bioaccumulative or 303(d) listed constituents to water bodies of the affected environment. As such, construction activities would not contribute measurably to bioaccumulation of contaminants in organisms or humans or cause 303(d) impairments to be discernibly worse. Relative to existing conditions, the construction-related effects would not be expected to cause or contribute to a substantial increased frequency of exceedances of water quality objectives/criteria, or substantially degrade water quality on a long-term average basis with respect to the constituents of concern, and thus would not adversely affect any beneficial uses in water bodies upstream of the Delta, within the Delta, or in the SWP and CVP service area. Based on these findings, this impact is determined to be less than significant. No mitigation is required.

8.3.4.2 Alternative 1A—Dual Conveyance with Tunnel and Intakes 1–5 (15,000 cfs; Operational Scenario A)

Alternative 1A would convey up to 15,000 cfs of water from the north Delta to the south Delta through pipelines/tunnels via five screened intakes on the east bank of the Sacramento River between Clarksburg and Walnut Grove. A new Byron Tract Forebay, adjacent to and south of Clifton Court Forebay, would be constructed which would provide water to the south Delta pumping plants. Water supply and conveyance operations would follow the guidelines described as Scenario A, which does not include fall X2. CM1–CM3 would improve the routing, timing, and amount of flow through the Delta. CM4–CM11 would restore, enhance, and manage physical habitats on a natural community scale. CM11–CM22 are designed to reduce *other stressors* on a species scale. See Chapter 3, *Description of Alternatives*, for additional details on Alternative 1A.

Impact WQ-1: Effects on ammonia concentrations resulting from facilities operations and maintenance (CM1)

Upstream of the Delta

For the same reasons stated for the No Action Alternative LLT, Alternative 1A LLT would have negligible, if any, effect on ammonia concentrations in the rivers and reservoirs upstream of the Delta relative to existing conditions and the No Action Alternative NT and LLT. Any negligible increases in ammonia-N concentrations that could occur in the water bodies of the affected environment in the Upstream of the Delta Region would not be of frequency, magnitude, and geographic extent that would adversely affect any beneficial uses or substantially degrade the quality of these water bodies, with regard to ammonia.

Delta

As summarized in Table 8-54, it is assumed that SRWTP effluent ammonia concentrations would be substantially lower under Alternative 1A LLT than under existing conditions or the No Action Alternative NT, and would be the same as would occur under the No Action Alternative LLT. Thus, for the same reasons stated for the No Action Alternative LLT, Alternative 1A LLT would not result in substantial increases in ammonia concentrations in the Plan Area, relative to existing conditions and the No Action Alternative NT.

Because the SRWTP discharge ammonia concentrations are assumed to be the same under Alternative 1A LLT as would occur under the No Action Alternative LLT, the primary mechanism that could potentially increase ammonia concentrations in the Delta under Alternative 1A, relative to the No Action Alternative LLT, is decreased flows in the Sacramento River, which would lower dilution available to the SRWTP discharge.

Table 8-54. Estimated Ammonia-N (mg-L as N) Concentrations in the Sacramento River Downstream of the Sacramento Regional Wastewaster Treatment Plant for the No Action Alternative LLT and Alternative 1A LLT

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual Average
No Action Alternative LLT	0.081	0.073	0.061	0.055	0.053	0.055	0.061	0.070	0.072	0.064	0.072	0.069	0.063
Alternative 1A LLT	0.074	0.077	0.061	0.055	0.053	0.055	0.061	0.067	0.068	0.070	0.080	0.085	0.063

To address this possibility, a simple mixing calculation was performed to assess concentrations of ammonia downstream of the SRWTP discharge (i.e., downstream of Freeport) under Alternative 1A LLT and the No Action Alternative LLT. Monthly average CALSIM II flows at Freeport and the upstream ammonia concentration (0.04 mg/L-N; Foe Central Valley Regional Water Quality Control Board 2010:5) were used, together with the SRWTP permitted average dry weather flow (181 mgd) and ammonia concentration (1.8 mg/L-N), to estimate the average change in ammonia concentrations downstream of the SRWTP. Table 8-54 shows monthly average and long term annual average predicted concentrations under the two scenarios.

As Table 8-54 shows, estimated ammonia-N concentrations in the Sacramento River downstream of Freeport (upon full mixing of the SRWTP discharge with river water) under Alternative 1A LLT and the No Action Alternative LLT are expected to be similar. Minor increases in ammonia-N concentrations would occur during July through September and in November, and remaining months would be unchanged or have a minor decrease. Annual average concentrations would be the same under both Alternative 1A LLT and the No Action Alternative LLT. Moreover, the estimated concentrations downstream of Freeport under Alternative 1A LLT would be similar to existing source water concentrations for the San Francisco Bay and San Joaquin River. Consequently, changes in source water fraction anticipated under Alternative 1A LLT, relative to the No Action Alternative LLT, would not be expected to substantially increase ammonia concentrations at any Delta locations.

Any negligible increases in ammonia-N concentrations that could occur at certain locations in the Delta would not be of frequency, magnitude, and geographic extent that would adversely affect any beneficial uses or substantially degrade the water quality at these locations, with regards to ammonia.

SWP/CVP Export Service Areas

The assessment of effects on ammonia in the SWP and CVP Export Service Area is based on assessment of ammonia-N concentrations at Banks and Jones pumping plants. The dominant source waters influencing the Banks and Jones pumping plants are the Sacramento and San Joaquin Rivers (see Appendix C). As discussed above for the Plan Area, for areas of the Delta that are influenced by Sacramento River water, including Banks and Jones pumping plants, ammonia-N concentrations are expected to decrease under Alternative 1A LLT, relative to existing conditions and No Action Alternative NT. This decrease in ammonia-N concentrations for water exported via the south Delta pumps is not expected to result in an adverse effect on beneficial uses or substantially degrade water quality of exported water, with regards to ammonia.

Furthermore, as discussed above for the Plan Area, for all areas of the Delta, including Banks and Jones pumping plants, ammonia-N concentrations would not be expected to substantially differ under Alternative 1A LLT, relative to No Action Alternative LLT. Any negligible increases in ammonia-N concentrations that could occur at Banks and Jones pumping plants would not be of frequency, magnitude, and geographic extent that would adversely affect any beneficial uses or substantially degrade the water quality at these locations, with regards to ammonia.

CEQA Conclusion: There would be no substantial, long-term increase in ammonia-N concentrations in the rivers and reservoirs upstream of the Delta, in the PlanArea, or the waters exported to the CVP and SWP service areas under Alternative 1 LLT relative to existing conditions. As such, this alternative would not be expected to cause additional exceedance of applicable water quality objectives/criteria by frequency, magnitude, and geographic extent that would cause significant impacts on any beneficial uses of waters in the affected environment. Because ammonia concentrations would not be expected to increase substantially, no long-term water quality degradation would be expected to occur and, thus, no significant impacts on beneficial uses would occur. Ammonia is not 303(d) listed within the affected environment and thus any minor increases that could occur in some areas would not make any existing ammonia-related impairment measurably worse because no such impairments currently exist. Because ammonia-N is not bioaccumulative, minor increases that could occur in some areas would not bioaccumulate to greater levels in aquatic organisms that would, in turn, pose substantial health risks to fish, wildlife, or humans. This impact would be considered less than significant. No mitigation is required.

Impact WQ-2: Effects on ammonia concentrations resulting from implementation of CM2–CM22

Some habitat restoration activities would occur on lands in the Delta formerly used for irrigated agriculture. Although this may decrease ammonia loading to the Delta from agriculture, increased biota in those areas as a result of restored habitat may increase ammonia loading originating from flora and fauna. Ammonia loaded from organisms is expected to be converted rapidly to nitrate by established microbial communities. Thus, these land use changes would not be expected to substantially increase ammonia concentrations in the Delta. In general, with the exception of changes in Delta hydrodynamics resulting from habitat restoration, CM2–CM11 would not substantially increase ammonia concentrations in the water bodies of the affected environment. Modeling scenarios included assumptions regarding how certain habitat restoration activities (CM2 and CM4) would affect Delta hydrodynamics, and thus such effects of these restoration measures were included in the assessment of CM1 facilities operations and maintenance (see Impact WQ-1). Additionally, implementation of CM12–CM22 would not be expected to substantially alter ammonia concentrations in the affected environment. There would be no adverse effect.

CEQA Conclusion: There would be no substantial, long-term increase in ammonia-N concentrations in the rivers and reservoirs upstream of the Delta, in the PlanArea, or the waters exported to the CVP and SWP service areas due to implementation of CM2–CM22 relative to existing conditions. As such, implementation of these conservations measures would not be expected to cause additional exceedance of applicable water quality objectives/criteria by frequency, magnitude, and geographic extent that would cause significant impacts on any beneficial uses of waters in the affected environment. Because ammonia concentrations would not be expected to increase substantially from implementation of these conservation measures, no long-term water quality degradation would be expected to occur and, thus, no significant impact on beneficial uses would occur. Ammonia is not 303(d) listed within the affected environment and thus any minor increases that could occur in some areas would not make any existing ammonia-related impairment measurably worse because no such impairments currently exist. Because ammonia-N is not bioaccumulative, minor increases that could occur in some areas would not bioaccumulate to greater levels in aquatic organisms that would, in turn, pose substantial health risks to fish, wildlife, or humans. This impact would be considered less than significant. No mitigation is required.

Impact WQ-3: Effects on boron concentrations resulting from facilities operations and maintenance (CM1)

Upstream of the Delta

Under Alternative 1A LLT there would be no expected change to the sources of boron in the Sacramento and east-side tributary watersheds. Boron loading in these watersheds would remain unchanged and resultant changes in flows from altered system-wide operations would have negligible, if any, effects on the concentration of boron in the rivers and reservoirs of these watersheds. Under Alternative 1A LLT, the modeled long-term annual average flows on the lower San Joaquin River at Vernalis would decrease by an estimated 6%, relative to existing conditions, and by 5% relative to No Action Alternative NT, and would remain virtually the same relative to No Action Alternative LLT. The reduced flow would result in possible increases in long-term average boron concentrations of about 2%, relative to the existing conditions and No Action Alternative NT conditions, with no change relative to No Action Alternative LLT. However, the small increases in lower San Joaquin River boron levels that may occur under Alternative 1A LLT, relative to existing conditions and the No Action Alternative NT conditions would not result in an increased frequency of exceedances of any applicable objectives or criteria. Moreover, any negligible change in boron concentration would not be expected to cause further degradation at measurable levels in the lower San Joaquin River, and thus would not cause the existing impairment there to be discernibly worse. Consequently, Alternative 1A LLT would not be expected to cause exceedance of boron objectives/criteria or substantially degrade water quality with respect to boron, and thus would not adversely affect any beneficial uses of the Sacramento River, the east-side tributaries, associated reservoirs upstream of the Delta, or the lower San Joaquin River.

Delta

Relative to the existing conditions, No Action Alternative NT, and No Action Alternative LLT, Alternative 1A LLT would result in similar or reduced long-term average boron concentrations for the 16-year period modeled at northern and eastern Delta locations (i.e., 14% reduction at North Bay Aqueduct at Barker Slough and 6% reduction at the San Joaquin River at Buckley Cove, compared to existing conditions) (Appendix 8F, Table Bo-6). Moreover, the direction and magnitude of predicted changes for Alternative 1A LLT are similar between the alternatives, thus, the effects relative to existing conditions and the No Action Alternative scenarios are discussed together. The long-term average boron concentrations for the 16-year period modeled would increase at interior and western Delta locations (by as much as 8% at the SF Mokelumne River at Staten Island, 13% at Franks Tract, 11% at Old River at Rock Slough, and 9% at the Sacramento River at Emmaton) (Appendix 8F, Table Bo-6). Additionally, implementation of tidal habitat restoration under conservation measure CM4 would increase the tidal exchange volume in the Delta, and thus may contribute to increased boron concentrations in the Bay source water as a result of increased salinity intrusion. While uncertain, the magnitude of boron increases may be greater than indicated herein and would affect the western Delta assessment locations the most which are influenced to the greatest extent by the Bay source water, and thus would not be anticipated to substantially affect agricultural diversions which occur primarily at interior Delta locations.

The long-term annual average and monthly average boron concentrations, for either the 16-year period or drought period modeled, would never exceed the 2,000 µg/L human health advisory objective (i.e., for children) or 500 µg/L agricultural objective at any of the eleven Delta assessment locations, which represents no change from the existing conditions and No Action Alternative NT and LLT conditions (Appendix 8F, Table Bo-3). Increased boron concentrations would result in minor reductions in the modeled long-term average assimilative capacity with respect to the 2,000 µg/L human health advisory objective. The reductions in long-term average assimilative capacity of up to 6% at interior Delta locations (i.e., Franks Tract and Old River at Rock Slough) also would be small with respect to the 500 µg/L agricultural objective (Appendix 8F, Table Bo-7). However, because the absolute boron concentrations would still be well below the lowest 500 µg/L objective for the protection of the agricultural beneficial use under Alternative 1A LLT, the levels of boron degradation would not be of sufficient magnitude to substantially increase the risk of exceeding objectives or cause adverse effects to municipal and agricultural water supply beneficial uses, or any other beneficial uses, in the Delta (Appendix 8F, Figure Bo-2).

SWP/CVP Export Service Areas

Under Alternative 1A LLT, improvement in long-term average boron concentrations would occur at the Banks and Jones pumping plants. Long-term average boron concentrations for the modeled 16-year hydrologic period at these locations would decrease by as much as 22% at Banks and by as much 18% at Jones relative to existing conditions, No Action Alternative NT, and No Action Alternative LLT (Appendix 8F, Table Bo-6). Commensurate with the decrease in boron concentrations in exported water to the San Joaquin River basin, there could be reduced boron loading and concentrations in the lower San Joaquin River related to irrigation water deliveries from the Delta. While the magnitude of this expected lower San Joaquin River improvement in boron is difficult to predict, the relative decrease in overall loading of boron to the export service area would likely alleviate or lessen any expected increase in boron concentrations at Vernalis associated with flow reductions (see discussion of Upstream of the Delta), as well locations in the Delta receiving a large fraction of San Joaquin River water, such as much of the south Delta. Reduced export boron concentrations also may contribute to reducing the existing 303(d) impairment in the lower San Joaquin River and associated TMDL actions for reducing boron loading.

Maintenance of SWP and CVP facilities under Alternative 1A LLT would not be expected to create new sources of boron or contribute towards a substantial change in existing sources of boron in the affected environment. Maintenance activities would not be expected to cause any substantial increases in boron concentrations or degradation with respect to boron such that objectives would be exceeded more frequently, or any beneficial uses would be adversely affected anywhere in the affected environment.

***CEQA Conclusion*:** Boron is not a bioaccumulative constituent, thus any increased concentrations under Alternative 1A LLT would not result in adverse boron bioaccumulation effects to aquatic life or humans. Relative to existing conditions, Alternative 1A LLT would not result in any substantial increases in boron concentration upstream of the Delta. Alternative 1A LLT maintenance also would not result in any substantial increases in boron concentrations in the affected environment. Relative to existing conditions, Alternative 1A LLT would not result in substantially increased boron concentrations such that frequency of exceedances of municipal and agricultural water supply objectives would increase. The levels of boron degradation that may occur under Alternative 1A LLT would not be of sufficient magnitude to cause substantially increased risk for adverse effects to municipal or agricultural beneficial uses within the affected environment. Long-term average boron concentrations would decrease in Delta water exports to the SWP and CVP service area, which may contribute to reducing the existing 303(d) impairment of agricultural beneficial uses in the lower San Joaquin River. Based on these findings, this impact is determined to be less than significant. No mitigation is required.

Impact WQ-4: Effects on boron concentrations resulting from implementation of CM2–CM22

The implementation of the other conservation measures (i.e., CM2-CM22), of which most do not involve land disturbance, present no new direct sources of boron to the affected environment, including areas Upstream of the Delta, within the Plan Area, and the SWP/CVP Export Service Area, nor would they affect channel flows or Delta hydrodynamic conditions. As noted above, the potential effects of implementation of tidal habitat restoration (i.e., conservation measure CM4) on Delta hydrodynamic conditions is addressed above in the discussion of Impact WQ-3. The potential channel flow effects of CM2 for actions in the Yolo Bypass also were accounted for in the CALSIM II and DSM2 modeling, and thus were addressed in the discussion for Impact WQ-3. Habitat restoration activities in the Delta (i.e., CM4-10), including restored tidal wetlands, floodplain, and related channel margin and off-channel habitats, while involving increased land and water interaction within these habitats, would not be anticipated to contribute boron which is primarily associated with source water inflows to the Delta (i.e., San Joaquin River, agricultural drainage, and Bay source water). Moreover, some habitat restoration conservation measures (CM410) would occur on lands within the Delta currently used for irrigated agriculture, thus replacing agricultural land uses with restored habitats. The potential reduction in irrigated lands within the Delta may result in reduced discharges of agricultural field drainage with elevated boron concentrations, which would be considered an improvement compared to existing conditions. CM3 and CM 11 provide the mechanism, guidance, and planning for the land acquisition and thus would not, themselves, affect boron levels in the Delta. CM12-CM22 involve actions that target reduction in other stressors at the species level involving actions such as methylmercury reduction management (CM12), improving DO in the Stockton Deep Water Ship Channel (CM14), and urban stormwater treatment (CM19). None of the CM12-CM22 actions would contribute to substantially increasing boron levels in the Delta. Consequently, as they pertain to boron, implementation of the conservation measures CM2-CM22 would not be expected to adversely affect any of the beneficial uses of the affected environment.

CEQA Conclusion: Implementation of the CM2-CM22 for Alternative 1A LLT would not present new or substantially changed sources of boron to the affected environment upstream of the Delta, within Delta, or in the SWP and CVP service area. As such, the their implementation would not be expected to substantially increase the frequency with which applicable Basin Plan objectives or other criteria would be exceeded in water bodies of the affected environment located upstream of the Delta, within the Delta, or in the SWP and CVP Service Area or substantially degrade the quality of these water bodies, with regard to Boron. Based on these findings, this impact is considered to be less than significant. No mitigation is required.

Impact WQ-5: Effects on bromide concentrations resulting from facilities operations and maintenance (CM1)

Upstream of the Delta

Under Alternative 1A LLT there would be no expected change to the sources of bromide in the Sacramento River and eastside tributary watersheds. Bromide loading in these watersheds would remain unchanged and resultant changes in flows from altered system-wide operations under Alternative 1A LLT would have negligible, if any, effects on the concentration of bromide in the rivers and reservoirs of these watersheds. Consequently, Alternative 1A LLT would not be expected to adversely affect the MUN beneficial use, or any other beneficial uses, of the Sacramento River, the eastside tributaries, or their associated reservoirs upstream of the Delta.

Under Alternative 1A LLT, modeling indicates that long-term annual average flows on the San Joaquin River would decrease by 6%, relativeto existing conditions, 5% relative to No Action Alternative NT, and would remain virtually the same relative to No Action Alternative LLT. Similar to the No Action Alternative LLT, these decreases in flow would result in possible increase in long-term average bromide concentrations of about 3%, relative to existing conditions, 2% relative to No Action Alternative NT, and less than <1% relative to No Action Alternative LLT. The small increases in lower San Joaquin River bromide levels that may occur under Alternative 1A LLT, relative to existing, No Action Alternative NT, and No Action Alternative LLT conditions would not be expected to adversely affect the MUN beneficial use, or any other beneficial uses, of the lower San Joaquin River.

Delta

Relative to existing conditions, Alternative 1A LLT would result in small decreases in long-term average bromide concentration at most Delta assessment locations, with the exceptions being the North Bay Aqueduct at Barker Slough, Staten Island, and Emmaton on the Sacramento River (Appendix 8E, Bromide Table 4-5). Overall effects would be greatest at Barker Slough, where predicted long-term average bromide concentrations would increase from 51 micrograms per liter (µg/L) to 71 µg/L (38% relative increase) for the modeled 16-year hydrologic period and would increase from 54 µg/L to 104 µg/L (94% relative increase) for the modeled drought period. At Barker Slough, the predicted 50 µg/L bromide threshold exceedance frequency would increase from 49% under existing conditions to 51% under Alternative 1A LLT (55% to 75% during the modeled drought period) and the predicted 100 µg/L exceedance frequency would increase from 0% under existing conditions to 22% under Alternative 1A LLT (0% to 48% during the modeled drought period). In contrast, increases in bromide at Staten Island would result in a 50 µg/L bromide threshold exceedance increase from 47% under existing conditions to 73% under Alternative 1A LLT (52% to 75% during the modeled drought period). However, unlike Barker Slough, modeling shows that the long-term average bromide concentrations at Staten Island would exceed the 100 µg/L assessment threshold concentration 1% under existing conditions and 3% under Alternative 1A LLT (0% to 2% during the modeled drought period). The long-term average bromide concentrations would be about 61 µg/L (62 µg/L during the modeled drought period) at Staten Island under Alternative 1A LLT. Changes in exceedance frequency of the 50 µg/L and 100 µg/L concentration thresholds, as well as relative change in long-term average concentration, at other assessment locations would be less substantial.

In comparison, Alternative 1A LLT relative to the No Action Alternative NT and No Action Alternative LLT would result in predicted increases in long-term average bromide concentrations at all locations with the exception of the Banks and Jones pumping plants. These increases would be of similar magnitude between No Action Alternative NT and No Action Alternative LLT comparisons, and would continue to be greatest at Barker Slough where long-term average concentrations are predicted to increase by about 45% (95% for the modeled drought period). Increases in long-term average bromide concentrations would be less than 31% at the remaining assessment locations. Due to the relatively small differences between modeled existing conditions and No Action Alternative baselines, changes in the frequency with which concentration thresholds of 50 µg/L and 100 µg/L are exceeded are of similar magnitude to those previously described for the existing condition comparison (Appendix 8E, Bromide Table 4-5).

The increase in long-term average bromide concentrations predicted at Barker Slough, principally the relative increase in the 100 µg/L exceedance frequency, would result in a substantial change in source water quality to existing drinking water treatment plants drawing water from the North Bay Aqueduct. Drinking water treatment plants in this region utilize a variety of conventional and enhanced treatment systems to achieve DBP drinking water criteria. Depending on the necessary disinfection requirements surrounding removal of pathogenic organisms, as well as the aggregate quality of water such as pH and alkalinity, a change in long-term average bromide of the magnitude predicted may necessitate changes in treatment plant operation or treatment plant facilities in order to maintain DBP compliance. For example, for a water treatment plant utilizing ozone to achieve disinfection equivalent to 1 or 2 log inactivation of *Giardia*, an increase in long-term average bromide above 50 µg/L may require pH control systems (California Urban Water Agencies 1998:4-18). For a water treatment plant utilizing chlorine to achieve 1 or 2 log inactivation of *Giardia*, an increased frequency of bromide in excess 100 µg/L may require a switch to ozonation with pH control (California Urban Water Agencies 1998: 4-20). While the implications of such a modeled change in bromide at Barker Slough are difficult to predict, the substantial modeled increases could lead to adverse changes in the formation of disinfection byproducts such that considerable water treatment plant upgrades would be necessary in order to achieve equivalent levels of health protection. This would be an adverse effect. Mitigation Measure WQ-5 is available to address this effect.

The seasonal intakes at Mallard Slough and city of Antioch are infrequently used because of water quality constraints related to sea water intrusion. On a long-term average, bromide at these locations exceeds 3,000 µg/L, but during seasonal periods of high Delta outflow levels can be <300 µg/L. Use of the seasonal intakes at Mallard Slough and city of Antioch under Alternative 1A LLT would experience a period average increase in bromide during the months when these intakes would most likely be utilized. For those wet and above normal water year types where mass balance modeling would predict water quality typically suitable for diversion, predicted long-term average bromide would increase from 103 µg/L to 173 µg/L (68% increase) at city of Antioch and would increase from 150 µg/L to 204 µg/L (36% increase) at Mallard Slough relative to existing conditions (Appendix 8E, Bromide Figure 2-3). Increases would be similar for No Action Alternative NT and No Action Alternative LLT comparisons. The decisions surrounding the use of these seasonal intakes is largely driven by acceptable water quality, and thus have historically been opportunistic. Opportunity to use these intakes would remain, and the predicted increases in bromide concentrations at the city of Antioch and Mallard Slough intake would not be expected to adversely affect MUN beneficial uses, or any other beneficial use, at these locations.

SWP/CVP Export Service Areas

Under Alternative 1A LLT, improvement in long-term average bromide concentrations would occur at the Banks and Jones pumping plants. Long-term average bromide concentrations for the modeled 16-year hydrologic period at these locations would decrease by as much as 37% relative to existing conditions, 32% relative to No Action Alternative NT, and 28% relative to No Action Alternative LLT. Relative changes in long-term average bromide concentrations would be less during drought conditions (≤31%), but would still represent considerable improvement (Appendix 8E, Bromide Tables 4-5). As a result, less frequent bromide concentration exceedances of the 50 μg/L and 100 μg/L assessment thresholds would be predicted and an overall improvement in water quality would be experienced respective to bromide in the SWP/CVP Export Service Areas. Commensurate with the decrease in exported bromide, an improvement in lower San Joaquin River bromide would also be observed because bromide in the lower San Joaquin River is principally related to irrigation water deliveries from the Delta. While the magnitude of this expected lower San Joaquin River improvement in bromide is difficult to predict, the relative decrease in overall loading of bromide to the Export Service Areas would likely alleviate or lessen any expected increase in bromide concentrations at Vernalis (see discussion of Upstream of the Delta) as well locations in the Delta receiving a large fraction of San Joaquin River water, such as much of the south Delta.

Similar to the discussion pertaining to the No Action Alternative LLT, maintenance of SWP and CVP facilities under Alternative 1A LLT would not be expected to create new sources of bromide or contribute a substantial change in existing sources of bromide in the affected environment. Maintenance activities would not be expected to cause any substantial change in bromide such that MUN beneficial uses, or any other beneficial use, would be adversely affected anywhere in the affected environment.

***CEQA Conclusion*:** Relative to existing conditions, Alternative 1A LLT operation and maintenance would not result in any substantial change in long-term average bromide concentration upstream of the Delta. Furthermore, under Alternative 1A LLT, water exported from the Delta to the SWP/CVP Export Service Areas would be substantially improved relative to bromide. Bromide is not bioaccumulative, therefore change in long-term average bromide concentrations would not directly cause bioaccumulative problems in aquatic life or humans. Additionally, bromide is not a constituent related to any 303(d) listings. Alternative 1A LLT operation and maintenance activities would not cause substantial degradation to water quality respective to bromide in the Plan Area with the exception of water quality at Barker Slough, source of the North Bay Aqueduct. At Barker Slough, modeled long-term annual average concentrations of bromide would increase by 38%, and 94% during the modeled drought period. For the modeled 16-year hydrologic period the frequency of predicted bromide concentrations exceeding 100 μg/L would increase from 0% under existing conditions to 22% under Alternative 1A LLT, while for the modeled drought period, the frequency would increase from 0% to 48%. Substantial changes in long-term average bromide could necessitate changes in water treatment plant operation or require treatment plant upgrades in order to maintain DBP compliance. The modeled change at Barker Slough is substantial and, therefore, would represent a substantially increased risk for significant impacts on existing MUN beneficial uses should treatment upgrades not be undertaken. The impact would be significant.Implementation of Mitigation Measure WQ-5 would reduce identified impacts on water quality from changes in bromide concentrations to a less-than-significant level by relocating the North Bay Aqueduct outside the influence of sea water intrusion.

Mitigation Measure WQ-5: Move the North Bay Aqueduct intake from Barker Slough to the Sacramento River

Implement the North Bay Aqueduct Alternative Intake Project (AIP). The North Bay Aqueduct AIP is an existing proposed project that would establish an alternate intake and pump station on the Sacramento River upstream of the Sacramento Regional Wastewater Treatment Plant (SRWTP) discharge. The alternate intake would connect to the existing North Bay Aqueduct pumping plant by a new segment of pipe.

Impact WQ-6: Effects on bromide concentrations resulting from implementation of CM2–CM22

CM12–CM22 would present no new sources of bromide to the affected environment, including areas Upstream of the Delta, within the Plan Area, and the SWP/CVPExport Service Areas. As they pertain to bromide, implementation of these conservation measures would not be expected to adversely affect MUN beneficial use, or any other beneficial uses, of the affected environment.

With exception to habitat restoration areas that would effectively alter Delta hydrodynamics, habitat restoration and the various land-disturbing conservation measures proposed for Alternative 1A would not present new or substantially changed sources of bromide to the project area. Modeling scenarios included assumptions regarding how certain habitat restoration activities would affect Delta hydrodynamics (CM2 and CM4), and thus such hydrodynamic effects of these restoration measures were included in the assessment of CM1 facilities operations and maintenance (see Impact WQ-1).

Some habitat restoration activities would occur on lands in the Delta formally used for irrigated agriculture. Such replacement or substitution of land use activity would not be expected to result in new or increased sources of bromide to the Delta. Implementation of CM2–CM11 would not be expected to adversely affect MUN beneficial use, or any other beneficial uses, within the affected environment.

CEQA Conclusion: Implementation of CM2–CM22 under Alternative 1A would not present new or substantially changed sources of bromide to the project area. Some conservation measures may replace or substitute for existing irrigated agriculture in the Delta. This replacement or substitution would not be expected to substantially increase or present new sources of bromide. Implementation of CM2–CM22 would have negligible, if any, effects on bromide concentrations throughout the affected environment, would not cause exceedance of applicable state or federal numeric or narrative water quality objectives/criteria because none exist for bromide, and would not cause changes in bromide concentrations that would result in significant impacts on any beneficial uses within affected water bodies. Implementation of CM2–CM22 would not cause significant long-term water quality degradation such that there would be greater risk of significant impacts on beneficial uses, would not cause greater bioaccumulation of bromide, and would not further impair any beneficial uses due to bromide concentrations because no uses are currently impaired due to bromide levels. Based on these findings, this impact would be less than significant. No mitigation is required.

Impact WQ-7: Effects on chloride concentrations resulting from facilities operations and maintenance (CM1)

Upstream of the Delta

Under Alternative 1A LLT there would be no expected change to the sources of chloride in the Sacramento and eastside tributary watersheds. Chloride loading in these watersheds would remain unchanged and resultant changes in flows from altered system-wide operations would have negligible, if any, effects on the concentration of chloride in the rivers and reservoirs of these watersheds. Under Alternative 1A LLT, the modeled long-term annual average flows on the lower San Joaquin River at Vernalis would decrease by an estimated 6%, relative to existing conditions, and by 5% relative to No Action Alternative NT, and would remain virtually the same relative to No Action Alternative LLT. The reduced flow would result in possible increases in long-term average chloride concentrations of about 2%, relative to the existing conditions and No Action Alternative NT conditions, and no change relative to No Action Alternative LLT. However, the small increases in lower San Joaquin River chloride levels that could occur under Alternative 1A LLT, relative to existing conditions and the No Action Alternative NT conditions would not result in an increased frequency of exceedances of any applicable objectives or criteria. Consequently, Alternative 1A LLT would not be expected to cause exceedance of chloride objectives/criteria or substantially degrade water quality with respect to chloride, and thus would not adversely affect any beneficial uses of the Sacramento River, the eastside tributaries, associated reservoirs upstream of the Delta, or the San Joaquin River.

Delta

Relative to existing conditions, Alternative 1A LLT would result in decreased long-term average chloride concentration at some assessment locations for the 16-year period modeled (i.e., 1976–1991), in particular at interior and south Delta assessment locations (i.e., San Joaquin River at Buckley Cove, Franks Tract, and Old River at Rock Slough) (Appendix 8G, Chloride Table Cl-6). Long-term average chloride concentrations would remain relatively unchanged at the San Joaquin River at Antioch and Contra Costa Canal at Pumping Plant #1 locations, and would increase at the Sacramento River at Emmaton (up 17%), Sacramento River at Mallard Island (up 4%), North Bay Aqueduct at Barker Slough (up 32%), and San Joaquin River at Staten Island (up 21%). Additionally, implementation of tidal habitat restoration under CM4 would increase the tidal exchange volume in the Delta, and thus may contribute to increased chloride concentrations in the Bay source water as a result of increased salinity intrusion. Consequently, while uncertain, the magnitude of chloride increases may be greater than indicated herein and would have the greatest effect on the western Delta assessment locations which are influenced to the greatest extent by the Bay source water. The following discussion outlines the modeled chloride changes relative to the applicable objectives and beneficial uses of Delta waters.

Municipal and Industrial Beneficial Uses

Relative to the 150 mg/L Bay-Delta WQCP objective for municipal and industrial beneficial uses, the plots of monthly average chloride concentrations at the Contra Costa Canal at Pumping Plant #1 for the separate water year types indicate that the number of months above the objective would either remain unchanged or decrease slightly, thus indicating there would not be an increased potential for exceedance of this objective compared to the existing conditions (Appendix 8G, Figure Cl-1). The modeled chloride concentrations at the San Joaquin River at Antioch location would never meet this objective under the No Action Alternative LLT; however, this represents no change from the existing conditions.

With respect to the 250 mg/L Bay-Delta WQCP objective, the frequency of exceedances based on monthly average chloride concentrations for the 16-year period modeled would increase at the San Joaquin River at Antioch location from 66% under existing conditions to 74%, and would increase by 2% at the Sacramento River at Mallard Island location (i.e., from 85% under existing conditions to 87%). The increased chloride concentrations at the Antioch and Mallard Slough locations would occur during the months of January through June, thus reducing water quality during the period of seasonal freshwater diversions (Appendix 8G, Figure Cl-2). The available assimilative capacity would decrease substantially at the Antioch location in the months of March and April (i.e., maximum reduction of 66% for the 16-year period modeled, and 100% reduction, or elimination of assimilative capacity, during the drought period modeled) (Appendix 8G, Table Cl-7). The frequency of exceedances at the Contra Costa Canal at Pumping Plant #1 would not increase (Appendix 8G, Table Cl-6); however, available assimilative capacity would be reduced compared to the existing conditions up to 100% in October (i.e., eliminated) (Appendix 8G, Table Cl-7). Additional long-term degradation at the Antioch and Contra Costa Canal at Pumping Plant #1 locations would occur when chloride concentrations would be near, or exceed, the objectives, thus increasing the risk of exceeding objectives. Based on the additional seasonal exceedances of the municipal objective and long-term water quality degradation with respect to chloride, the potential exists for adverse effects on the municipal and industrial beneficial uses in the western Delta, particularly at the Antioch intake, through reduced opportunity for diversion of water with acceptable chloride levels.

Aquatic Life Beneficial Uses

Relative to the 230 mg/L chronic USEPA aquatic life criterion, monthly average chloride concentrations at the northern and eastern Delta locations would not exceed the criteria and the frequency of exceedances at most interior and southern Delta locations would generally not change or decrease slightly for the 16-year period modeled (Appendix 8G, Table Cl-6). Reductions in the modeled assimilative capacity would occur at some locations during the January through June period of the 16-year period modeled (e.g., maximum reduction of 32% at Franks Tract and 25% at Old River at Rock Slough) (Appendix 8G, Table Cl-8). However, the reduced assimilative capacity would not result in substantial adverse effects on aquatic organisms because the absolute concentrations during these months would be less than the criteria (Appendix 8G, Figure Cl-3).

303(d) Listed Water Bodies

With respect to the 303(d) listing for chloride in Tom Paine Slough, the monthly average chloride concentrations for the 16-year period modeled at Old River at Tracy Road would generally be similar or lower compared to existing conditions, and thus, would not be further degraded on a long-term basis (Appendix 8G, Figure Cl-3). With respect to Suisun Marsh, the long-term average chloride concentration at the Sacramento River at Mallard Island for the 16-year period modeled would increase by 91 mg/L (4%) compared to existing conditions (Appendix 8G, Table Cl-5), and chloride concentrations would increase in some months during October through May at Mallard Island (Appendix 8G, Figure Cl-2) and in the Sacramento River at Collinsville (Appendix 8G, Figure Cl-4). Monthly average chloride concentrations at the Montezuma Slough at Beldon's Landing would increase substantially compared to existing conditions in October through May, with over a doubling of concentrations in December through February (Appendix 8G, Figure Cl-5). The most substantial increase would occur near Beldon's Landing, with long-term average EC levels increasing by 1.8–6.1

mS/cm, depending on the month, which would be a long-term average EC relative to existing conditions. Therefore, additional, measurable long-term degradation would occur in Suisun Marsh that potentially would adversely affect the necessary actions to reduce chloride loading for any TMDL that is developed.

Relative to the No Action Alternative NT and No Action Alternative LLT conditions, Alternative 1A would result in increased long-term average chloride concentrations for the 16-year period modeled at nine of the assessment locations (Appendix 8G, Table Cl-5). The increases in long-term average chloride concentrations would be largest compared to the No Action Alternative NT condition, ranging from 1% at the San Joaquin River at Buckley Cove to 37% at the North Bay Aqueduct at Barker Slough. Long-term average chloride concentrations would decrease at the Banks and Jones pumping plant locations. The modeled chloride changes relative to the applicable objectives and potential effects on beneficial uses are as follows.

SWP/CVP Export Service Areas

Under Alternative 1A LLT, long-term average chloride concentrations for the 16-year period modeled at the Banks and Jones pumping plants would decrease by as much as 33% relative to existing conditions, 31% relative to No Action Alternative NT, and 28% compared to No Action Alternative LLT. The modeled frequency of exceedances of applicable water quality objectives/criteria would decrease relative to existing conditions, No Action Alternative NT, and No Action Alternative LLT, for both the 16-year period and the drought period modeled (Appendix 8G, Chloride Table Cl-6). Consequently, water exported to the SWP/CVP service area would generally be of similar or better quality with regard to chloride relative to existing conditions and the No Action Alternative NT and No Action Alternative LLT conditions.

Commensurate with the decrease in exported chloride concentrations, an improvement in lower San Joaquin River chloride would also be anticipated to occur because chloride in the lower San Joaquin River is principally related to irrigation water deliveries from the Delta. While difficult to predict, the relative decrease in overall loading of chloride to the SWP/CVP Export Service Areas would likely alleviate or lessen any expected increase in chloride at Vernalis related to decreased annual average San Joaquin River flows (see discussion of Upstream of the Delta).

Maintenance of SWP and CVP facilities would not be expected to create new sources of chloride or contribute a substantial change in existing sources of chloride in the affected environment. Maintenance activities would not be expected to cause any substantial change in chloride such that any long-term water quality degradation would occur, thus, beneficial uses would not be adversely affected.

***CEQA Conclusion*:** Chloride is not a bioaccumulative constituent, thus any increased concentrations under Alternative 1A LLT would not result in significant chloride bioaccumulation impacts on aquatic life or humans. Alternative 1A LLT maintenance would not result in any substantial changes in chloride concentration upstream of the Delta or in the SWP/CVP Export Service Areas.

Relative to existing conditions, Alternative 1A LLT would result in substantially increased chloride concentrations such that frequency of exceedances of the 250 mg/L Bay-Delta WQCP objective would increase within the Plan Area at the San Joaquin River at Antioch (by 8%) and at Mallard Slough (by 2%) that could result in significant impacts on the municipal and industrial water supply beneficial use at these locations. Additionally, further long-term degradation would occur at Antioch, Mallard Slough, and Contra Costa Canal at Pumping Plant #1 locations when chloride concentrations would be near, or exceed, the objectives, thus increasing the risk of exceeding objectives. Relative to the existing conditions, the modeled increased chloride concentrations and degradation in the western Delta could further contribute, at measurable levels (i.e., over a doubling of concentrations) to the existing 303(d) listed impairment due to chloride in Suisun Marsh for the protection of fish and wildlife. Based on these findings, this impact would be significant due to increased chloride concentrations and degradation at western and interior Delta locations and its impacts on municipal and industrial water supply and fish and wildlife beneficial uses.

While implementation of Mitigation Measure WQ-7 may reduce the significance of this impact, the feasibility and effectiveness of this mitigation measures is uncertain. Therefore, this would be a significant and unavoidable impact.

Mitigation Measure WQ-7: Conduct additional evaluation and modeling of increased chloride levels and develop and implement phased actions to reduce levels

The effects of increased chloride levels, and potential adverse effects on municipal and industrial water supply and fish and wildlife beneficial uses associated with conservation measure CM1 operations (and hydrodynamic effects of tidal restoration under CM4), may be mitigated through a variety of actions designed to reduce, avoid, or compensate for elevated chloride levels. It remains to be determined whether, or to what degree, the available and existing salinity response and countermeasure actions of SWP and CVP facilities, municipal water purveyors, or Suisun Marsh salinity control facilities would be capable of accommodating the actual level of changes in chloride that may occur from implementation of Alternative 1A. Therefore, the proposed mitigation measures require a phased implementation of actions to identify and evaluate existing and possible feasible actions, followed by development and implementation of additional measures, if determined to be necessary and feasible. The phased actions for reducing chloride levels and associated significant impacts on municipal and industrial water supply also could mitigate significant impacts on aquatic life.

Mitigation Measure WQ-7a: The BDCP proponents will conduct additional evaluations, and develop additional modeling (as necessary), to define the extent to which modified operations could reduce or eliminate the additional exceedances of the 250 mg/L Bay-Delta WQCP objective for chloride currently modeled to occur under Alternative 1A The additional evaluations will consider specifically the changes in Delta hydrodynamic conditions associated with tidal habitat restoration under CM4 (in particular the potential for increased chloride concentrations that could result from increased tidal exchange), once the specific restoration locations are identified and designed. BDCP proponents would then coordinate with responsible resource management agencies and municipal and industrial water purveyors to identify the capability of available operations of these entities to accommodate anticipated changes in chloride concentrations. Following this further definition of the actual effects of Alternative 1A, and the operational flexibility to either reduce or accommodate such effects, additional phased actions would be developed and implemented.

To reduce the effects of CM1/CM4 operations on increased chloride concentrations predicted to occur in the interior and western Delta, in particular, the BDCP proponents will develop modified, or new, operational scenarios to minimize or avoid the causes leading to increased chloride concentrations, where feasible and consistent with other operational obligations. Based on the modeled conditions, the emphasis would be identification of feasible actions to reduce elevated chloride conditions during the seasonal period of October through May, and drought period conditions in particular. [*Note to Lead Agencies: feasible actions are currently in preparation.*]

Mitigation Measure WQ-7b: To reduce the effects of CM1/CM4 operations on increased chloride concentrations specifically predicted to occur to municipal and industrial water purveyors at the Antioch, Mallard Slough, and Contra Costa Canal at Pumping Plant #1 locations, the BDCP proponents will coordinate with the purveyors to identify the operational means to compensate for reduced seasonal availability of water with acceptable salinity. [*Note to Lead Agencies: feasible actions are currently in preparation.*]

Mitigation Measure WQ-7c: To reduce the effects of CM1/CM4 operations on increased chloride concentrations specifically predicted to occur in the Suisun Marsh, the BDCP proponents will coordinate with DFG/USFWS to identify the means to reduce the predicted chloride level increases in the marsh, with the goal of maintaining chloride at levels that would not further impair fish and wildlife beneficial uses in Suisun Marsh. Potential actions may include modifications of the existing Suisun Marsh Salinity Control Gates for effective salinity control and evaluation of the efficacy of additional physical salinity control facilities for the marsh. Based on the modeled conditions, the emphasis would be identification of feasible actions to reduce elevated chloride conditions during the seasonal period of January through May. [*Note to Lead Agencies: feasible actions are currently in preparation.*]

Mitigation Measure WQ-7d: To reduce the effects of tidal habitat restoration CM4 on potential increased chloride concentrations, in particular the effects anticipated to influence conditions primarily at western Delta locations, the responsible agencies assigned to lead the restoration efforts will design and implement restoration areas to minimize tidal exchange to the extent possible that allows achievement of the restoration objectives. Siting of the restoration areas will have effects on tidal exchange and thus chloride levels in various areas of the Delta, particularly the western and interior Delta. As such, the siting and design of the wetland restoration areas is a component of this mitigation measure. [*Note to Lead Agencies: feasible actions are currently in preparation.*]

Impact WQ-8: Effects on chloride concentrations resulting from implementation of CM2–CM22

The implementation of the other conservation measures (i.e., CM2–CM22), of which most do not involve land disturbance, present no new direct sources of chloride to the affected environment, including areas Upstream of the Delta, within the Plan Area, and the SWP/ CVP Export Service Area, nor would they affect channel flows or Delta hydrodynamic conditions. As noted above, the potential effects of implementation of tidal habitat restoration (i.e., conservation measure CM4) on Delta hydrodynamic conditions is addressed above in the discussion of Impact WQ-8. The potential channel flow effects of CM2 for actions in the Yolo Bypass also were accounted for in the CALSIM II and DSM2 modeling, and thus were addressed in the discussion for Impact WQ-8. CM3 and CM11 provide the mechanism, guidance, and planning for the land acquisition and thus would not, themselves, affect chloride levels in the Delta. CM12–CM22 involve actions that target reduction in other stressors at the species level involving actions such as methylmercury reduction management (CM12), improving DO in the Stockton Deep Water Ship Channel (CM14), and urban stormwater treatment (CM19). None of CM12-CM22 would contribute to substantially increasing chloride levels in the Delta. Consequently, as they pertain to chloride, implementation of the conservation measures CM2-CM22 would not be expected to adversely affect any of the beneficial uses of the affected environment. Moreover, some habitat restoration conservation measures (CM4-10) would occur on lands within the Delta currently used for irrigated agriculture, thus replacing agricultural land uses with restored tidal wetlands, floodplain, and related channel margin and off-channel habitats. The potential reduction in irrigated lands within the Delta may result in reduced discharges of agricultural field drainage with elevated chloride concentrations, which would be considered an improvement compared to existing conditions.

***CEQA Conclusion*:** Implementation of the CM2–CM22 for Alternative 1A LLT would not present new or substantially changed sources of chloride to the affected environment upstream of the Delta, within Delta, or in the SWP/CVP service area. Replacement of irrigated agricultural land uses in the Delta with habitat restoration conservation measures may result in some reduction in discharge of agricultural field drainage with elevated chloride concentrations, thus resulting in improved water quality conditions. Based on these findings, this impact is considered to be less than significant. No mitigation is required.

Impact WQ-9: Effects on dissolved oxygen resulting from facilities operations and maintenance (CM1)

Upstream of the Delta

For the same reasons stated for the No Action Alternative LLT, Alternative 1A LLT would not result in substantial decreases in DO levels in the rivers and reservoirs upstream of the Delta relative to existing conditions and the No Action Alternative NT and LLT. Any minor decreases in DO levels that could occur under Alternative 1A LLT would not be of sufficient frequency, magnitude, and geographic extent to result in adverse effects on beneficial uses within the Upstream of the Delta Region,or substantially degrade the quality of these water bodies, with regard to DO.

Delta

For the same reasons stated for the No Action Alternative LLT, Alternative 1A LLT would not result in substantial decreases in DO levels in the Delta relative to existing conditions and the No Action Alternative NT and LLT. Any minor decreases in DO levels that could occur under Alternative 1A LLT would not be of sufficient frequency, magnitude, and geographic extent to result in adverse effects on beneficial uses in the Plan Area,or substantially degrade the quality of these water bodies, with regard to DO.

SWP/CVP Export Service Areas

The water delivered to the SWP/CVP Export Service Areas would differ from that under existing conditions as it would consist of water directly withdrawn from the Delta at the current export pumps and water diverted from the Sacramento River at Hood. DO levels in the vicinity of the south Delta export pumps may be reduced occasionally, but would not be anticipated to be substantially lower at this location on a long-term basis, relative to existing conditions. The DO levels in water entering the canals from the new facilities that diverted the water from the Sacramento River at Hood would be expected to be equal to or higher than DO levels at the south Delta export pumps, and would be expected to have similar or lower levels of oxygen demanding substances. Hence, the typical DO level of water entering the SWP/CVP Export Service Areas waters would not be expected to be substantially lower than that under existing conditions. DO dynamics within the exposed canals and the downstream reservoirs would remain similar to that under existing conditions.

Consequently, effects on DO levels in the SWP/CVP Export Service Areas would not be adverse under Alternative 1A LLT relative to existing conditions.

For the same reasons given above, substantial adverse effects on DO levels in the SWP/CVP Export Service Areas are not expected to occur under Alternative 1A LLT relative to the No Action Alternative NT and LLT.

CEQA Conclusion: There would be no substantial, and likely no measurable, long-term change in DO levels in the Upstream of the Delta Region, in the Plan Area, or in the SWP/CVP Export Service Areas under Alternative 1A LLT, relative to existing conditions. Therefore, this alternative is not expected to cause additional exceedance of applicable water quality objectives by frequency, magnitude, and geographic extent that would result in significant impacts on any beneficial uses within affected water bodies. Because no substantial changes in DO levels are expected, long-term water quality degradation would not be expected to occur, and, thus, beneficial uses would notbe adversely affected. Various Delta waterways are 303(d)-listed for low DO, but because no substantial decreases in DO levels would be expected, greater degradation and DO-related impairment of these areas would not be expected. This impact would be less than significant. No mitigation is required.

Impact WQ-10: Effects on dissolved oxygen resulting from implementation of CM2–CM22

CM2–CM22 would not be expected to contribute to adverse DO levels in the Delta. The increased habitat provided by CM2–CM11 could contribute to an increased biochemical or sediment demand, through plants decaying. However, similar habitat exists currently in the Delta and is not identified as contributing to adverse DO conditions. CM14, an oxygen aeration facility in the Stockton Deep Water Ship Channel to meet TMDL objectives established by the Central Valley Water Board, would maintain DO levels above those that impair fish species when covered species are present. CM19, which would fund projects to contribute to reducing pollutant discharges in stormwater, would be expected to reduce biochemical oxygen demand load and, thus, would not adversely affect DO levels. The remaining conservation measures would not be expected to affect DO levels because they are actions that do not affect the presence of oxygen-demanding substances.

CEQA Conclusion: It is expected that DO levels in the Upstream of the Delta Region, in the Plan Area, or in the SWP/CVP Export Service Areas following implementation of CM2–CM22 under Alternative 1A would not be substantially different from existing DO conditions. Therefore, this alternative is not expected to cause additional exceedance of applicable water quality objectives by frequency, magnitude, and geographic extent that would result in significant impacts on any beneficial uses within affected water bodies. Because no substantial changes in DO levels would be expected, long-term water quality degradation wouldnot be expected, and, thus, beneficial uses would not be adversely affected. Various Delta waterways are 303(d)-listed for low DO, but because no substantial decreases in DO levels would be expected, greater degradation and impairment of these areas would not be expected. Implementation of CM14 would have a net beneficial effect on DO conditions in the Stockton Deep Water Ship Channel. This impact would be less than significant. No mitigation is required.

Impact WQ-11: Effects on electrical conductivity concentrations resulting from facilities operations and maintenance (CM1)

Upstream of the Delta

For the same reasons stated for the No Action Alternative LLT, EC levels (highs, lows, typical conditions) in the Sacramento River and its tributaries, the eastside tributaries, their associated reservoirs, and the San Joaquin River upstream of the Delta under Alternative 1A LLT are not expected to be outside the ranges occurring under existing conditions or would occur under the No Action Alternative NT and LLT. Any minor changes in EC levels that may occur under Alternative 1A LLT in water bodies upstream of the Delta would not be of sufficient magnitude, frequency and geographic extent that would cause adverse effects on beneficial uses or substantially degrade water quality with regard to EC.

Delta

Relative to existing conditions, Alternative 1A LLT would result in a fewer number of days when Bay-Delta WQCP compliance locations in the western, interior, and southern Delta would exceed EC objectives or be out of compliance with the EC objectives, with the exception of the San Joaquin River at San Andreas Landing in the interior Delta and Brandt Bridge in the southern Delta (Appendix H, Table EC-1). The percent of days the San Andreas Landing EC objective would be exceeded for the entire period modeled (1976-1991) would increase from 1% under existing conditions to 2% under Alternative 1A LLT. Further, the percent of days out of compliance with the EC objective would increase from 1% under existing conditions to 5% under Alternative 1A LLT. At Brandt Bridge, the increase in days of EC objective exceedance and days out of compliance would be <1%. Average EC levels at the western and southern Delta compliance locations would decrease from 1-27% for the entire period modeled and 2-28% during the drought period modeled (1987-1991) (Appendix H, Table EC-12). At the two interior Delta compliance locations, there would be increases in average EC: the S. Fork Mokelumne River at Terminous average EC would increase 4% for the entire period modeled and 3% during the drought period modeled; and San Joaquin River at San Andreas Landing average EC would increase 12% for the entire and drought periods modeled. On average, EC would increase at San Andreas Landing during all months except November. Average EC in the S. Fork Mokelumne River at Terminous would increase during all months (Appendix H, Table EC-12). Of the Clean Water Act section 303(d) listed sections of the Delta – western, northwestern, and southern – only the San Joaquin River at Brandt Bridge in the southern Delta would have a slight increase (<1%) in the exceedance of the Bay-Delta WQCP EC objectives (Appendix H, Table EC-1), and long-term average EC at this location would decrease by 2%, relative to existing conditions, for the entire period modeled (Appendix H, Table EC-12). Thus, Alternative 1A LLT is not expected to contribute to additional impairment and adversely affect beneficial uses for section 303(d) listed Delta waterways, relative to existing conditions.

Relative to the No Action Alternative NT, the change in percent compliance with Bay-Delta WQCP EC objectives under Alternative 1A LLT would be similar to that described above relative to existing conditions. The exception is that there would also be a slight increase (1% or less) in the percent of days the EC objective would be exceeded in the San Joaquin River at Vernalis and in Old River near Middle River, located in the southern Delta, for the entire period modeled. For the entire period modeled, average EC levels would increase at all Delta compliance locations relative to the No Action Alternative NT, except in Three Mile Slough near the Sacramento River. The greatest average EC increase would occur in the San Joaquin River at San Andreas Landing (23%); the increase at the other locations would be 3-8% (Appendix H, Table EC-12). During the drought period modeled, average EC would increase at all locations, except Three Mile Slough and San Joaquin River at Jersey Point. The greatest average EC increase during the drought period modeled would occur in the San Joaquin River at San Andreas Landing (21%); the increase at the other locations would be 1-5% (Appendix H, Table EC-12). Given that the southern Delta is Clean Water Act section 303(d) listed as impaired due to elevated EC, the increase in the incidence of exceedance of EC objectives and increases in long-term and drought period average EC at the southern Delta locations under Alternative 1A LLT, relative to the No Action Alternative NT, has the potential to contribute to additional impairment and potentially adversely affect beneficial uses.

Relative to the No Action Alternative LLT, the locations with an increased frequency of exceedance of the Bay-Delta WQCP EC objectives under Alternative 1A LLT would differ from that described relative to the No Action Alternative NT (Appendix H, Table EC-1). The percent of days exceeding EC objectives and percent of days out of compliance would increase at: San Joaquin River at Jersey Point, San Andreas Landing, Brandt Bridge, and Prisoners Point; and Old River near Middle River at Tracy Bridge. The increase in percent of days exceeding the EC objective would be 2% or less and the increase in percent of days out of compliance would be 4% or less. Average EC would increase at some compliance locations for the entire period modeled: San Joaquin River at Jersey Point (3%), S. Fork Mokelumne River at Terminous (5%), San Joaquin River at San Andreas Landing (18%), and San Joaquin River at Prisoners Point (9%) (Appendix H, Table EC-12). For the drought period modeled, the locations with an average EC increase would be: S. Fork Mokelumne River at Terminous (4%), San Joaquin River at San Andreas Landing (13%), San Joaquin River at Brandt Bridge (1%), Old River at Tracy Bridge (1%), and San Joaquin River at Prisoners Point (4%) (Appendix H, Table EC-12). Given that the western and southern Delta is Clean Water Act section 303(d) listed as impaired due to elevated EC, the increase in the incidence of exceedance of EC objectives and increases in long-term and drought period average EC at the western and southern Delta locations under Alternative 1A LLT, relative to the No Action Alternative LLT, has the potential to contribute to additional impairment and potentially adversely affect beneficial uses.

For Suisun Marsh, October-May is the period when Bay-Delta WQCP EC objectives for protection of fish and wildlife apply. Average EC for the entire period modeled would increase under Alternative 1A LLT, relative to existing conditions, during the months of February through May by 0.1-0.8 mS/cm in the Sacramento River at Collinsville (Appendix H, Table EC-21). Long-term average EC would decrease relative to existing conditions in Montezuma Slough at National Steel during October-May (Appendix H, Table EC-22). The most substantial increase would occur near Beldon Landing, with long-term average EC levels increasing by 1.8-6.1 mS/cm, depending on the month, which would be a doubling or tripling of long-term average EC relative to existing conditions (Appendix H, Table EC-23). Sunrise Duck Club and Volanti Slough also would have long-term average EC increases during all months of 1.9-4.0 mS/cm (Appendix H, Tables EC-24 and EC-25). The degree to which the long-term average EC increases would cause exceedance of Bay-Delta WQCP objectives is unknown, because objectives are expressed as a monthly average of daily high tide EC, which does not have to be met if it can be demonstrated "equivalent or better protection will be provided at the location" (State Water Resources Control Board 2006:14). The described long-term average EC increase may, or may not, contribute to adverse effects on beneficial uses, depending on how and when wetlands are flooded, soil leaching cycles, and how recirculation of water is managed, and future actions taken with respect to the marsh. However, the EC increases at certain locations would be substantial and it is uncertain the degree to which current management plans for the Suisun Marsh would be able to address these substantially higher EC levels and protect beneficial uses. Thus, these increased EC levels in Suisun Marsh are considered to have a potentially adverse effect on marsh beneficial uses. Long-term average EC increases in Suisun Marsh under Alternative 1A LLT relative to the No Action Alternative NT and LLT would be similar to the increases relative to existing conditions. Suisun Marsh is section 303(d) listed as impaired due to elevated EC, and the potential increases in long-term average EC concentrations could contribute to additional impairment, because the increases would be double or triple that relative to existing conditions and the No Action Alternative NT and LLT.

SWP/CVP Export Service Areas

At the Banks and Jones pumping plants, Alternative 1A LLT would result in no exceedances of the Bay-Delta WQCP's 1,000 μmhos/cm EC objective for the entire period modeled (Appendix H, Table EC-10). Thus, there would be no adverse effect to the beneficial uses in the SWP/CVP Export Service Areas using water pumped at this location under Alternative 1A LLT.

At the Banks pumping plant, relative to existing conditions, average EC levels under Alternative 1A LLT would decrease 22% for the entire period modeled and 18% during the drought period modeled. Relative to the No Action Alternative NT, average EC levels would decrease by 15% for the entire period modeled and 12% during the drought period modeled. Similar decreases in average EC would occur relative to the No Action Alternative LLT. (Appendix H, Table EC-12)

At the Jones pumping plant, relative to existing conditions, average EC levels under Alternative 1A LLT would decrease 19% for the entire period modeled and 17% during the drought period modeled. Relative to the No Action Alternative NT, average EC levels would decrease by 13% for the entire period modeled and 12% during the drought period modeled. Similar decreases in average EC levels would occur relative to the No Action Alternative LLT. (Appendix H, Table EC-12)

Based on the decreases in long-term average EC levels that would occur at the Banks and Jones pumping plants, Alternative 1A LLT would not cause degradation of water quality with respect to EC in the SWP/CVP Export Service Areas; rather, Alternative 1A LLT would improve long-term average EC conditions in the SWP/CVP Export Service Areas.

Commensurate with the EC decrease in exported waters, an improvement in lower San Joaquin River average EC levels would be expected since EC in the lower San Joaquin River is, in part, related to irrigation water deliveries from the Delta. While the magnitude of this expected lower San Joaquin River improvement in EC is difficult to predict, the relative decrease in overall loading of EC-elevating constituents to the Export Service Areas would likely alleviate or lessen any expected increase in EC at Vernalis related to decreased annual average San Joaquin River flows (see EC impact discussion under No Action Alternative LLT).

The export area of the Delta is listed on the state's CWA Section 303(d) list as impaired due to elevated EC. Alternative 1A LLT would result in lower average EC levels relative to existing conditions and the No Action Alternative NT and LLT and, thus, would not contribute to additional beneficial use impairment related to elevated EC in the SWP/CVP Export Service Areas waters. Rather, Alternative 1A LLT would have beneficial effects on EC in the SWP/CVP Export Service Areas, relative to existing conditions and the No Action Alternative NT.

***CEQA Conclusion*:** Relative to existing conditions, Alternative 1A LLT would not result in any substantial increases in long-term average EC levels upstream of the Delta or in the SWP/CVP Export Service Areas. In the Plan Area, Alternative 1A LLT would result in an increase of 1% in the frequency with which Bay-Delta WQCP EC objectives for agricultural beneficial use protection are exceeded in the San Joaquin River at San Andreas Landing (interior Delta) for the entire period modeled (1976-1991). Further, average EC levels at San Andreas Landing would increase by 12% for the entire and drought periods modeled. Because EC is not bioaccumulative, the increases in long-term average EC levels would not directly cause bioaccumulative problems in aquatic life or humans. The interior Delta is not Clean Water Act section 303(d) listed for elevated EC, and other portions of the Delta that are section 303(d) listed would not have increased long-term average EC levels. The increases in long-term and drought period average EC levels and increased frequency of exceedance of EC objectives that would occur in the San Joaquin River at San Andreas Landing would potentially contribute to adverse effects on the agricultural beneficial uses in the interior Delta. This impact is considered to be potentially significant.

Further, relative to existing conditions, Alternative 1A LLT would result in substantial increases in long-term average EC during the months of October through May in Suisun Marsh, such that EC levels at would be up to double or triple that occurring under existing conditions. The increases in long-term average EC levels that would occur in Suisun Marsh would further degrade existing EC levels and could contribute additionally to adverse effects on the fish and wildlife beneficial uses. Because EC is not bioaccumulative, the increases in long-term average EC levels would not directly cause bioaccumulative problems in wildlife. Suisun Marsh is Clean Water Act section 303(d) listed for elevated EC and the increases in long-term average EC that would occur in the marsh could make beneficial use impairment measurably worse. This impact is considered to be potentially significant.

While Mitigation Measure WQ-11 may reduce these impacts, the feasibility and effectiveness of this mitigation measures is uncertain. Therefore, the available mitigation would not necessarily reduce the impact to a level that would be less than significant.

Mitigation Measure WQ-11: Reduce, avoid, and compensate for reduced water quality conditions

The effects of increased EC levels, and potential adverse effects on beneficial uses associated with conservation measure CM1 operations (and hydrodynamic effects of tidal restoration under CM4), may be mitigated through a variety of actions designed to reduce, avoid, or compensate for elevated EC levels. The goal of specific actions would be to reduce/eliminate additional exceedances of Delta EC objectives and reduce long-term average concentration increases to levels that would not adversely affect beneficial uses within the Delta and Suisun Marsh. It remains to be determined whether, or to what degree, the available and existing salinity response and countermeasure actions of SWP and CVP facilities, municipal water purveyors, or Suisun Marsh salinity control facilities would be capable of accommodating the actual level of changes in EC that may occur from implementation of Alternative 1A. Therefore, the proposed mitigation requires a phased implementation of actions to identify and evaluate existing and possible feasible actions, followed by development and implementation of additional measures, if determined to be necessary and feasible. The phased actions for reducing EC levels and associated adverse effects on agricultural water supply also could mitigate adverse effects on fish and wildlife life. The phased actions, timing, and responsible parties for development and implementation are the same as those described for Mitigation Measure WQ-7.

Impact WQ-12: Effects on electrical conductivity resulting from implementation of CM2-CM22

The implementation of the other conservation measures (i.e., CM2–CM22), of which most do not involve land disturbance, present no new direct sources of EC to the affected environment, including areas upstream of the Delta, within the Delta region, and in the SWP/CVP Export Service Areas. As they pertain to EC, implementation of these conservation measures would not be expected to adversely affect any of the beneficial uses of the affected environment. Moreover, some habitat restoration conservation measures would occur on lands within the Delta currently used for irrigated agriculture. Such replacement or substitution of land use activity is not expected to result in new or increased sources of EC to the Delta and, in fact, could decrease EC through elimination of high EC agricultural runoff.

CM4 would result in substantial tidal habitat restoration that would increase the magnitude of daily tidal water exchange at the restoration areas, and alter other hydrodynamic conditions in adjacent Delta channels. The DSM2 modeling included assumptions regarding possible locations of tidal habitat restoration areas, and how restoration would affect Delta hydrodynamic conditions, and thus the effects of this restoration measure on Delta EC were included in the assessment of CM1 facilities operations and maintenance.

Implementation of CM2–CM22 would not be expected to adversely affect EC levels in the affected environment and thus would not adversely affect beneficial uses or substantially degrade water quality with regard to EC within the affected environment.

CEQA Conclusion: Implementation of CM2–CM22 under Alternative 1A LLT would not present new or substantially changed sources of EC to the affected environment. Some conservation measures may replace or substitute for existing irrigated agriculture in the Delta. This replacement or substitution is not expected to substantially increase or present new sources of EC, and could actually decrease EC loads to Delta waters. Thus, implementation of CM2–CM22 would have negligible, if any, adverse effects on EC levels throughout the affected environment and would not cause exceedance of applicable state or federal numeric or narrative water quality objectives/criteria that would result in adverse effectson any beneficial uses within affected water bodies. Further, implementation of CM2–CM22would not cause significant long-term water quality degradation such that there would be greater risk of adverse effects on beneficial uses. Based on these findings, this impact is considered to be less than significant. No mitigation is required.

Impact WQ-13: Effects on mercury concentrations resulting from facilities operations and maintenance (CM1)

[*Note to Lead Agencies: This assessment is in preparation*].

Impact WQ-14: Effects on mercury concentrations resulting from implementation of CM2–CM22

[*Note to Lead Agencies: This assessment is in preparation*].

Impact WQ-15: Effects on nitrate concentrations resulting from facilities operations and maintenance (CM1)

Upstream of the Delta

For the same reasons stated for the No Action Alternative LLT, Alternative 1A LLT would have negligible, if any, adverse effects on nitrate concentrations in the rivers and reservoirs upstream of the Delta in the Sacramento River watershed, relative to existing conditions and the No Action Alternative NT and LLT.

Under Alternative 1A LLT, modeling indicates that long-term annual average flows on the San Joaquin River would decrease by an estimated 6%, relative to existing conditions, 5% relative to No Action NT, and would remain virtually the same relative to No Action LLT (Appendix 5A). Given these relatively small decreases in flows and the weak correlation between nitrate and flows in the San Joaquin River (see Nitrate Appendix J Figure 2), it is expected that nitrate concentrations in the San Joaquin River will be minimally affected, if at all, by changes in flow rates under Alternative 1A LLT.

Any negligible changes in nitrate-N concentrations that may occur in the water bodies of the affected environment located upstream of the Delta would not be of frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the quality of these water bodies, with regards to nitrate.

Delta

Results of the mixing calculations indicate that under Alternative 1A LLT, relative to existing conditions, No Action NT, and No Action LLT, nitrate concentrations throughout the Delta are anticipated to remain low (<1.4 mg/L-N) relative to adopted objectives (Nitrate Appendix J Table 7 and 8). Although changes at specific Delta locations and for specific months may be substantial on a relative basis, the absolute concentration of nitrate in Delta waters would remain low (<1.4 mg/L-N) in relation to the drinking water MCL of 10 mg/L-N, as well as all other thresholds identified in Table XX. Long-term average nitrate concentrations are anticipated to remain below 1 mg/L-N at all 11 assessment locations except the San Joaquin River at Buckley Cove, where long-term average concentrations would be somewhat above 1 mg/L-N. Nevertheless, at this location, long-term average nitrate concentration would be somewhat reduced under Alternative 1A LLT, relative to existing conditions and the No Action NT, and would be nearly the same (i.e., any increase would be negligible) as that under the No Action LLT. No additional exceedances of the MCL are anticipated at any location (Nitrate Appendix J Table 7). On a monthly average basis and on a long term annual average basis, for all modeled years and for the drought period (1987-1991) only, use of assimilative capacity available under existing conditions, No Action NT, and No Action LLT, relative to the drinking water MCL of 10 mg/L-N, was low or negligible (i.e., <5%) for all locations and months (Nitrate Appendix J Table 9).

Nitrate concentrations will likely be higher than the modeling results indicate in certain locations, including: (1) in the Sacramento River between Freeport and Mallard Island and other areas in the Delta downstream of Freeport that are influenced by Sacramento River water, the increase becoming greater with increasing distance downstream, due to conversion of ammonia from the SRWTP discharge at Freeport (under existing conditions and No Action Alternative NT only, since upgrades to SRWTP that substantially reduce ammonia concentrations in the Sacramento River downstream of Freeport are assumed in the LLT; see the Ammonia section of this chapter for further discussion); (2) immediately downstream of wastewater treatment plants that practice nitrification, but not denitrification (e.g., City of Rio Vista Beach WWTF, Town of Discovery Bay WWTF, City of Stockton RWCF).

The effect of (1) (above) is expected to be small, on the order of 1 mg/L nitrate as N or less in the existing conditions and No Action Alternative NT. This is because the existing increase appears to be from approximately 0.1 mg/L-N to approximately 0.4-0.5 mg/L-N over this reach, due to approximately a 1:1 conversion of ammonia-N to nitrate-N (CVWQCB 2010:32). Because this nitrate is assumed not to be generated under Alternative 1A LLT, average concentrations would be expected to decrease under Alternative 1A LLT in this reach of the Sacramento River relative to existing conditions and the No Action Alternative NT. Regarding number (2) (above), for all such facilities in the Delta, the Regional Water Boards have issued NPDES permits that allow discharge of wastewater containing nitrate into the Delta, and under these permits, the State has determined that no beneficial uses are adversely affected by the discharge, and that the discharger's use of available assimilative capacity of the water body is acceptable. When dilution is necessary in order for the discharge to be in compliance with the Basin Plans (which incorporate the 10 mg/L-N MCL by reference), not all of the assimilative capacity of the receiving water is granted to the discharger. Thus, limited decreases in flows are not anticipated to result in systemic exceedances of the MCLs by these POTWs. Furthermore, NPDES permits are renewed on a 5-year basis, and thus, if under changes in flows, dilution was no longer sufficient to maintain nitrate below the MCL in the receiving water, the NPDES permit renewal process would address such cases.

Therefore, any increases in nitrate-N concentrations that may occur at certain locations within the Delta would not be of frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the water quality at these locations, with regards to nitrate.

SWP/CVP Export Service Areas

Assessment of effects of nitrate in the SWP and CVP Export Service Areas is based on effects on nitrate-N at the Banks and Jones pumping plants.

Results of the mixing calculations indicate that under Alternative 1A LLT, relative to existing conditions, No Action NT, and No Action LLT, nitrate concentrations at Banks and Jones pumping plants are anticipated to decrease on a long-term average annual basis (Nitrate Appendix J Table 7 and 8). During the late summer, particularly in the drought period assessed, concentrations are expected to increase substantially on a relative basis (i.e., >50%), but the absolute value of these changes (i.e., in mg/L-N) is small. Additionally, given the many factors that contribute to potential algal blooms in the SWP and CVP canals within the Export Service Area, and the lack of studies that have shown a direct relationship between nutrient concentrations in the canals and reservoirs and problematic algal blooms in these water bodies, there is no basis to conclude that these small (i.e., generally <0.3 mg/L-N), seasonal increases in nitrate concentrations would increase the potential for problem algal blooms in the SWP and CVP Export Service Area. No additional exceedances of the MCL are anticipated (Nitrate Appendix J Table 7). On a monthly average basis and on a long term annual average basis, for all modeled years and for the drought period (1987-1991) only, use of assimilative capacity available under existing conditions and No Action NT, relative to the 10 mg/L-N MCL, was negligible for both Banks and Jones pumping plants (Nitrate Appendix J Table 9).

Any increases in nitrate-N concentrations that may occur in water exported via Banks and Jones pumping plants are not expected to result in an adverse effects to beneficial uses or substantially degrade the quality of exported water, with regards to nitrate.

***CEQA Conclusion*:** There would be no substantial, long-term increase in nitrate-N concentrations in the rivers and reservoirs upstream of the Delta, in the Delta Region, or the waters exported to the CVP and SWP service areas under Alternative 1A LLT relative to existing conditions. As such, this alternative is not expected to cause additional exceedance of applicable water quality objectives/criteria by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. Because nitrate concentrations are not expected to increase substantially, no long-term water quality degradation is expected to occur and, thus, no adverse effects to beneficial uses would occur. Nitrate is not 303(d) listed within the affected environment and thus any increases than may occur in some areas and months would not make any existing nitrate-related impairment measurably worse because no such impairments currently exist. Because nitrate is not bioaccumulative, increases that may occur in some areas and months would not bioaccumulate to greater levels in aquatic organisms that would, in turn, pose substantial health risks to fish, wildlife, or humans. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-16: Effects on nitrate concentrations resulting from implementation of CM2–CM22

Some habitat restoration activities included in CM2–CM11 would occur on lands within the Delta formerly used for agriculture. It is expected that this will decrease nitrate concentrations in the Delta, due to less use of nitrate-based fertilizers, relative to existing conditions and the No Action Alternative. Modeling scenarios included assumptions regarding how certain habitat restoration activities (i.e., CM 2 and CM 4) would affect Delta hydrodynamics, and thus such effects of these restoration measures were included in the assessment of CM1 facilities operations and maintenance (see Impact WQ-1). In general, aside from changes in Delta hydrodynamics resulting from habitat restoration discussed in Impact WQ-1, conservation measures CM2–CM11 proposed for Alternative 1A LLT are not expected to increase nitrate concentrations in water bodies of the affected environment, relative to existing conditions and the No Action Alternative.

Because urban stormwater is a source of nitrate in the affected environment, conservation measure CM19, Urban Stormwater Treatment, is expected to slightly reduce nitrate loading to the Delta, thus slightly decreasing nitrate-N concentrations relative to existing conditions and the No Action Alternative. Implementation of CM12–CM18 and CM20–CM22 is not expected to substantially alter nitrate concentrations in any of the water bodies of the affected environment.

***CEQA Conclusion*:** There would be no substantial, long-term increase in nitrate-N concentrations in the rivers and reservoirs upstream of the Delta, in the Delta Region, or the waters exported to the CVP and SWP service areas due to implementation of CM2–CM22 under Alternative 1A LLT, relative to existing conditions. Because urban stormwater is a source of nitrate in the affected environment, conservation measure CM19, Urban Stormwater Treatment, is expected to slightly reduce nitrate loading to the Delta. As such, implementation of these conservation measures is not expected to cause additional exceedance of applicable water quality objectives/criteria by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. Because nitrate concentrations are not expected to increase substantially due to these conservation measures, no long-term water quality degradation is expected to occur and, thus, no adverse effects to beneficial uses would occur. Nitrate is not 303(d) listed within the affected environment and thus any minor increases than may occur in some areas would not make any existing nitrate-related impairment measurably worse because no such impairments currently exist. Because nitrate is not bioaccumulative, minor increases that may occur in some areas would not bioaccumulate to greater levels in aquatic organisms that would, in turn, pose substantial health risks to fish, wildlife, or humans. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-17: Effects on organic carbon concentrations resulting from facilities operations and maintenance (CM1)

Upstream of the Delta

Under Alternative 1A LLT, there would be no substantial change to the sources of DOC within the watersheds upstream of the Delta. Moreover, long-term average flow and DOC levels in the Sacramento River at Hood and San Joaquin River at Vernalis are poorly correlated. Thus changes in system operations and resulting reservoir storage levels and river flows would not be expected to cause a substantial long-term change in DOC concentrations in the water bodies upstream of the Delta. Any negligible changes in DOC levels in water bodies upstream of the Delta under Alternative 1A LLT, relative to existing conditions and the No Action Alternative NT and LLT, would not be of sufficient frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the quality of these water bodies, with regard to DOC.

Delta

Relative to existing conditions, Alternative 1A LLT would result in small increases (i.e., between 1 and 9%) in long-term average DOC concentrations at some interior Delta locations. In particular, modeled increases in long-term average DOC would be greatest at Franks Tract, with net average DOC concentration increases for the 16-year (1976–1991) hydrologic period modeled of 0.3 mg/L, equivalent to an approximate 9% relative increase (0.2 mg/L for the drought period, 8% relative increase) (Appendix 8K, DOC Table 2). Long-term increases of not greater than 0.3 mg/L (≤8%) would be predicted to occur at Staten Island, Rock Slough, and Contra Costa PP No. 1 as well. At all 11 assessment locations, modeled long-term average DOC concentrations exceed 2 mg/L 92-100% of the time. However, increases in long-term average DOC in the Delta interior would result in more frequent exceedances of the 3 mg/L concentration threshold, with the largest magnitude effect occurring at Rock Slough and Contra Costa PP No. 1. At Rock Slough, the frequency long-term average DOC concentrations would exceed 3 mg/L would increase from 52% under existing conditions to 66% under Alternative 1A LLT (an increase from 47% to 63% for the drought period). At Contra Costa PP No. 1, the frequency long-term average DOC concentrations would exceed 3 mg/L would increase from 52% under existing conditions to 68% under Alternative 1A LLT (an increase from 45% to 67% for the drought period). In contrast, however, the relative frequency long-term average DOC concentrations would exceed 4 mg/L at Rock Slough and Contra Costa PP No. 1 would be small. At Rock Slough, an increase in the frequency long-term average DOC would exceed 4 mg/L would only occur for the drought period, increasing from 32% under existing conditions to 40% under Alternative 1A LLT, while at Contra Costa PP No.1 the modeled exceedance frequency for the 16-year hydrologic period would rise from 32% to 34% (an increase from 35% to 42% for the drought period). Concentration threshold exceedances at the other assessment locations would be similar or less. While Alternative 1A LLT would generally lead to slightly higher long-term average DOC concentrations (≤0.3 mg/L) within the Delta interior and some municipal water intakes, the predicted change would not be expected to adversely affect MUN beneficial uses, or any other beneficial use.

In comparison, Alternative 1A LLT relative to the No Action Alternative NT and No Action Alternative LLT would generally result in a similar magnitude of change to that discussed for the comparison to existing conditions. Maximum increases of not greater than 0.3 mg/L DOC (i.e., ≤9%) would be predicted at Staten Island, Franks Tract, Rock Slough, and Contra Costa PP No. 1(Appendix 8K, DOC Table 2). Threshold concentration exceedance frequency trends would also be similar to that discussed for the existing condition comparison, with exception to the predicted 4 mg/L exceedance frequency at Buckley Cove. In comparison to the No Action Alternative NT, the frequency which long-term average DOC concentrations exceeded 4 mg/L at Buckley Cove would increase from 23% to 33% (37% to 62% for the modeled drought period), with slightly smaller increases when comparing to No Action Alternative LLT. While the Alternative 1A LLT would generally lead to slightly higher long-term average DOC concentrations at some Delta assessment locations when compared to No Action Alternative NT and No Action Alternative LLT conditions, the predicted change would not be expected to adversely affect MUN beneficial uses, or any other beneficial use, particularly when considering the relatively small change in long-term annual average concentration.

The Stage 1 Disinfectants and Disinfection Byproduct Rule adopted by U.S. EPA in 1998, as part of the Safe Drinking Water Act, requires drinking water utilities to reduce TOC concentrations by specified percentages prior to disinfection. EPA's action thresholds begin at 2-4 mg/L TOC and, depending on source water alkalinity, may require a drinking water utility to employ treatment to achieve as much as a 35% reduction in TOC. These requirements were adopted because organic carbon, such as DOC, can react with disinfectants during the water treatment disinfection process to form DBPs, such as THMs which pose potential lifetime carcinogenic risks to humans. Moreover, a CUWA convened expert panel reviewed Delta source water quality and DBP formation potential in an effort to develop Delta source water quality targets for treated drinking water. This panel found that source water between 4 and 7 mg/L TOC would allow continued flexibility in treatment technology necessary to achieve existing drinking water criteria for DPBs.

Water treatment plants that utilize Delta water are currently designed and operated to meet EPA's 1998 requirements based on the ambient concentrations and seasonal variability that currently exists in the Delta. Substantial changes in ambient DOC concentrations would need to occur for significant changes in plant design or operations to be triggered. The increases in long-term average DOC concentrations estimated to occur at various Delta locations under Alternative 1A are of sufficiently small magnitude that they will not require existing drinking water treatment plants to substantially upgrade treatment for DOC removal above levels currently employed.

Relative to existing conditions, No Action Alternative NT, and No Action Alternative LLT conditions, Alternative 1A LLT would lead to predicted improvements in long-term average DOC concentrations at Barker Slough, Banks and Jones pumping plants. At these locations, long-term average DOC concentrations would be predicted to decrease by as much as <0.1 - 0.5 mg/L, depending on baseline comparison.

SWP/CVP Export Service Areas

Under Alternative 1A LLT, modeled long-term average DOC concentrations would decrease at Banks and Jones pumping plants, relative to existing conditions, No Action Alternative NT, and No Action Alternative LLT. Relative to existing conditions, long-term average DOC concentrations would be predicted to decrease by 0.4 mg/L at both pumping plants, although in drought years the decrease would be 0.1 mg/L at Banks pumping plant and <0.1 mg/L at Jones pumping plant (Appendix 8K, DOC Table 2). Such decreases in long-term average DOC would result in generally lower exceedance frequencies for concentration thresholds, although the frequency of exceedance during the modeled drought period (i.e., 1987-1991) would be predicted to increase. For the Banks pumping plant during the drought period, exceedance of the 3 mg/L threshold would increase from 57% under existing conditions to 88% under Alternative 1A LLT, while at the Jones pumping plant, exceedance frequency would increase from 72% to 87%. There would be comparatively fewer increases in the frequency of exceeding the 4 mg/L threshold at Banks, while at Jones pumping plant the exceedance frequency for the 4 mg/L threshold would decrease. Comparisons to No Action Alternative NT and No Action Alternative LLT yield similar trends, but with slightly small magnitude drought period changes. Overall, modeling results for the SWP/CVP Export Service Areas predict an overall improvement in Export Service Areas water quality, although somewhat more frequent exports of >3mg/L DOC water would likely occur for drought periods.

Similar to the discussion pertaining to the No Action Alternative LLT, maintenance of SWP and CVP facilities under Alternative 1A LLT would not be expected to create new sources of DOC or contribute towards a substantial change in existing sources of DOC in the affected area. Maintenance activities would not be expected to cause any substantial change in long-term average DOC concentrations such that MUN beneficial uses, or any other beneficial use, would be adversely affected.

***CEQA Conclusion*:** Relative to existing conditions, Alternative 1A LLT operation and maintenance would not result in any substantial change in long-term average DOC concentration upstream of the Delta or result in substantial increase in the frequency with which long-term average DOC concentrations exceeds 2, 3, or 4 mg/L levels at the 11 assessment locations analyzed for the Delta. Modeled long-term average DOC concentrations would increase by no more than 0.3 mg/L at any single Delta assessment location (i.e., ≤9% relative increase), with long-term average concentrations estimated to remain at or below 4.0 mg/L at all Delta locations assessed, with the exception of Buckley Cove on the San Joaquin River during the drought period modeled. Nevertheless, long-term average concentrations at Buckley Cove are predicted to remain the same during the drought period, relative to existing conditions. The increases in long-term average DOC concentration that could occur within the Delta would not be of sufficient magnitude to adversely affect the MUN beneficial use, or any other beneficial uses, of Delta waters or waters of the SWP/CVP Service Area. Because DOC is not bioaccumulative, the increases in long-term average DOC concentrations would not cause bioaccumulative problems in aquatic life or humans. Finally, DOC is not causing beneficial use impairments and thus is not 303(d) listed for any water body within the affected environment. Thus, the increases in long-term average DOC that could occur at various locations would not make any beneficial use impairment measurably worse. Because long-term average DOC concentrations are not expected to increase substantially, no long-term water quality degradation with respect to DOC is expected to occur and, thus, no adverse effects on beneficial uses would occur This impact is considered to be less than significant. No mitigation is required.

Impact WQ-18: Effects on organic carbon concentrations resulting from implementation of CM2–CM22

The mostly non-land disturbing CM12–CM22 present no new sources of DOC to the affected environment, including areas Upstream of the Delta, within the Plan Area, and the SWP/CVP Export Service Area. Implementation of methyl mercury control measures (CM12) and urban stormwater treatment measures (CM19) may result in beneficial effects, to the extent that control measures treat or reduce organic carbon loading from tidal wetlands and urban land uses. Control of nonnative aquatic vegetation (CM13) may include killing mature aquatic vegetation in place, leading to their decay and contribution to DOC in Delta channels. However, this measure is not expected to be a significant source of long-term DOC loading as vegetation control would be sporadic and on an as needed basis, with decreasing need for treatments in the long-term as nonnative vegetation is eventually controlled and managed. Implementation of CM12–CM22 would not be expected to have substantial, if even measurable, effect on DOC concentrations upstream of the Delta, within the Delta, and in the SWP/CVP service areas. Consequently, any negligible increases in DOC levels in these areas of the affected environment are not expected to be of sufficient frequency, magnitude and geographic extent that they would adversely affect the MUN beneficial use, or any other beneficial uses, of the affected environment, nor would potential increases substantially degrade water quality with regards to DOC.

For CM2–CM11, effects on DOC concentrations can generally be considered in terms of: (1) alternative-caused change in Delta hydrodynamics, and (2) alternative-caused change in Delta DOC sources. Change in Delta hydrodynamics involves a two part process, including the conveyance facilities and operational scenarios of CM1, as well the change in Delta channel geometry and open water areas that would occur as a consequence of implementing tidal wetland restoration measures such as that described for CM4. Modeling scenarios included assumptions regarding how these habitat restoration activities would affect Delta hydrodynamics, and thus the effects of these restoration measures, via their effects on delta hydrodynamics, were included in the assessment of CM1 facilities operations and maintenance (see Impact WQ-17). The potential for these same conservation measures to change Delta DOC sources are addressed below.

CM2, CM3, CM8, CM9, and CM11 could include activities that would target increasing primary production (i.e., algae growth) within the Delta. Algae currently are not estimated to be a major source of DOC in the Delta (CALFED Bay-Delta Program 2008: 4, 6), and comprise mostly the particulate fraction of TOC. Conventional drinking water treatment removes much of the POC from raw source water; therefore, conservation measured activities targeted at increased algae production are not expected to contribute substantial amounts of new DOC, or adversely affect MUN beneficial use, or any other beneficial uses, of the affected environment.

CM4–CM7 and CM10 include land disturbing restoration activities known to be sources of DOC. Research within the Delta has focused primarily on non-tidal wetlands and flooding of Delta island peat soils. The dynamics of DOC production and export from wetlands and seasonally flooded soils is complex, as well highly site and circumstance specific. Age and configuration of a wetland significantly affects the amount of DOC that may be generated in a wetland. In a study of a permanently flooded non-tidal constructed wetland on Twitchell Island, initial DOC loading was determined to be much greater (i.e., approximately 10 times greater) than equivalent area of agricultural land, but trends in annual loading led researchers to estimate that loading from the wetland would be equivalent to that of agriculture within about 15 years (Fleck et. al. 2007: 18). It was observed that the majority of the wetland load originated from seepage through peat soils. Trends in declining load were principally associated with flushing of mobile DOC from submerged soils, the origins of which were related to previous agricultural activity prior to restoration to wetland. Peaks in annual loading, however, would be different, where peaks in agricultural drainage occur in winter months while peaks in wetland loading occur in spring and summer months. As such, age, configuration, location, operation, and season all factor into DOC loading, and long-term average DOC concentrations in the Delta.

Available evidence suggests that restoration activities establishing new tidal and non-tidal wetlands, new riparian and new seasonal floodplain habitat could potentially lead to new substantial sources of localized DOC loading within the Delta. If established in areas presently used for agriculture, these restoration activities could result in a substitution and temporary increase in localized DOC loading for years. Presently, the specific design, operational criteria, and location of these activities are not well established. Depending on localized hydrodynamics, such restoration activities could contribute substantial amounts of DOC to municipal raw water if established near municipal intakes. Substantially increased DOC concentrations in municipal source water may create a need for existing drinking water treatment plants to upgrade treatment systems in order to achieve EPA Stage 1 Disinfectants and Disinfection Byproduct Rule action thresholds. While treatment technologies sufficient to achieve the necessary DOC removals exist, implementation of such technologies would likely require substantial investment in new or modified infrastructure.

CEQA Conclusion: Implementation of CM2, CM3, CM8, CM9, and CM11–CM22 would not present new or substantially changed sources of organic carbon to the affected environment of the Delta, and thus would not contribute substantially to changes in long-term average DOC concentrations in the Delta. Therefore, related long-term water quality degradation would not be expected to occur and, thus, no adverse effects on beneficial uses would occur through implementation of CM2, CM3, CM8, CM9, and CM11–CM22. Furthermore, DOC is not bioaccumulative, therefore changes in DOC concentrations would not cause bioaccumulative problems in aquatic life or humans. Nevertheless, implementation of CM4–CM7 and 10 would present new localized sources of DOC to the project area, and in some circumstances would substitute for existing sources related to replaced agriculture. Depending on localized hydrodynamics and proximity to municipal drinking water intakes, such restoration activities could contribute substantial amounts of DOC to municipal raw water. The potential for substantial increases in long-term average DOC concentrations related to the habitat restoration elements of CM4–CM7 and 10 could contribute to long-term water quality degradation with respect to DOC and, thus, adversely affect MUN beneficial uses. The impact is considered to be significant and mitigation is required. It is uncertain whether implementation of Mitigation Measure WQ-18 would reduce identified impacts to a less than significant level. Hence, this impact could remain significant after mitigation.

Mitigation Measure WQ-18: Design wetland and riparian habitat features to minimize effects on municipal intakes

Design wetland and riparian habitat features taking into consideration effects on Delta hydrodynamics and impacts on municipal intakes. Locate restoration features such that impacts on municipal intakes are minimized and habitat benefits are maximized. Incorporate design features to control the load and/or timing of DOC exports from habitat restoration features. This could include design elements to control seepage from non-tidal wetlands, and features to increase sinuosity in tidal wetlands and riparian and channel margin habitat designs. For restoration features directly connected to open channel waters, designing wetlands with only channel margin exchange would decrease DOC loading. Stagger construction of wetlands and channel margin/riparian sites both spatially and temporally so as to allow aging of the restoration features and associated decreased creation of localized "hot spots" and net Delta loading.

Establish a performance metric and monitoring program to help guide the design and creation of the target wetland habitats. For example, restoration activities will be designed and located so as to prevent net long-term average DOC concentration increases of greater than 0.5 mg/L at any municipal intake location within the Delta.

Impact WQ-19: Effects on pathogens resulting from facilities operations and maintenance (CM1)

Upstream of the Delta

For the same reasons stated for the No Action Alternative LLT, Alternative 1A LLT would not result in substantial, and likely immeasurable, increases in pathogen concentrations in the rivers and reservoirs upstream of the Delta, relative to existing conditions and the No Action Alternative NT and LLT. Effects due to the operation and maintenance of the conveyance facilities are expected to be immeasurable, on an annual and long-term average basis.

Delta

For the same reasons stated for the No Action Alternative LLT, Alternative 1A LLT would not result in substantial, and likely immeasurable, increases in pathogen concentrations in the Delta region relative to existing conditions and the No Action Alternative NT and LLT. Effects due to the operation and maintenance of the conveyance facilities are expected to be immeasurable, on an annual and long-term average basis.

SWP/CVP Export Service Areas

The water delivered to the SWP/CVP Export Service Areas would differ from that under existing conditions and the No Action Alternative NT and LLT, as it would consist of water diverted from the Sacramento River at Hood in addition to the water directly withdrawn from the Delta at the current export pumps.

The Pathogens Conceptual Model (Tetra Tech 2007, Figure 3-7) reports the median *E. coli* concentration in the Sacramento River at Hood is the same order of magnitude (10^1) as the median *E. coli* concentration at the Contra Costa Water District's Pumping Plant #1 and the Delta Pumping Plant Headworks (referred to herein as the Banks pumping plant), with the median Banks pumping plant concentrations being higher than the Sacramento River and Pumping Plant #1 median concentrations (data for comparison of total coliforms and fecal coliforms is not presented in Tetra Tech 2007 and, thus, only *E. coli* is discussed). Based on the Pathogen Conceptual Model's findings that Delta *E. coli* concentrations appear to be largely influenced by localized sources and that Sacramento River *E. coli* concentrations are lower than Delta concentrations, the diversion of Sacramento River water at Hood is not expected to measurably increase the *E. coli* concentration in the SWP/CVP Export Service Areas waters.

Furthermore, the following average pathogen concentrations for the Sacramento River at River Mile 44 (which is upstream of Hood and downstream of the Sacramento Regional Wastewater Treatment Plant) are reported in the Pathogens Conceptual Model (Tetra Tech 2007, Figure 3-4):

Cryptosporidium: 0.12 oocysts/L (31% of samples detected)

Giardia: 0.9 cysts/L ml (66% of samples detected)

Pathogen concentrations in SWP/CVP Export Service Areas waters, particularly *Giardia* and *Cryptosporidium* concentrations, are of concern because the concentration of these pathogens dictates the level treatment required for the drinking water supply. The *California State Water Project Sanitary Survey, 2006 Update* (Archibald Consulting 2007) reported *Giardia* and *Cryptosporidium* concentrations for locations throughout the SWP. These pathogens were not frequently detected and the concentrations reported were such that the waters would be classified as "Bin 1" under the Long Term 2 Enhanced Surface Water Treatment Rule (LT2ESWTR), meaning no additional treatment required under the Rule, though some waters required additional monitoring to confirm this classification. Based on the levels of *Cryptosporidium* in the Sacramento River, this alternative would not be expected to adversely affect the municipal and domestic water supply uses in the service areas, as the water would be classified as "Bin 1" with respect to the LT2ESWTR, meaning no additional treatment required.

With respect to the remaining beneficial uses in the service area (e.g., recreation), an increased proportion of water coming from the Sacramento River would not adversely affect those uses in the SWP/CVP Export Service Areas. As described above, the pathogen levels in the Sacramento River are to similar to or lower than the water diverted at the Delta export pumps. Further, it is localized sources of pathogens that appear to have to greatest influence on concentrations (Tetra Tech 2007). Thus, an increased proportion of Sacramento River water diverted to the SWP/CVP ExportService Areas would result in minimal changes in pathogen levels in the SWP/CVP Export Service Areas waters.

For the same reasons stated for the No Action Alternative, Alternative 1A LLT is expected to have minimal effects on pathogen concentrations in SWP/CVP Export Service Areas waters relative to existing conditions and No Action Alternative NT and LLT.

CEQA Conclusion: There would be no substantial, and likely no measurable, increase in average pathogen concentrations in the rivers and reservoirs upstream of the Delta, Delta region, and SWP/CVP Export Service Areas due to implementation of CM1 (water facilities and operations) under Alternative 1A LLT relative to existing conditions. Therefore, this alternative is not expected to cause additional exceedance of applicable water quality objectives by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. Because pathogen concentrations are not expected to increase substantially, no long-term water quality degradation for pathogens is expected to occur and, thus, no adverse effects on beneficial uses would occur. The San Joaquin River in the Stockton Deep Water Ship Channel is Clean Water Act section 303(d) listed for pathogens. Because no measurable increase in Deep Water Ship Channel pathogen concentrations are expected to occur on a long-term basis, further degradation and impairment of this area is not expected to occur. Finally, pathogens are not bioaccumulative constituents. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-20: Effects on pathogens resulting from implementation of CM2–CM22

CM2–CM11 would involve habitat restoration actions, and CM22 involves waterfowl and shorebird areas. Tidal wetlands are known to be sources of coliforms originating from aquatic, terrestrial, and avian wildlife that inhabit these areas (Desmarais et al. 2001, Grant et al. 2001, Evanson and Ambrose 2006, Tetra Tech 2007). Specific locations of restoration areas for this alternative have not yet been established. However, most low-lying land suitable for restoration is unsuitable for livestock. Therefore, it is likely that the majority of land to be converted to wetlands would be crop-based agriculture or fallow/idle land. Because of a great deal of scientific uncertainty in the loading of coliforms from these various sources, the resulting change in coliform loading is uncertain, but it is anticipated that coliform loading to Delta waters would increase. Based on findings from the Pathogens Conceptual Model that pathogen concentrations are greatly influenced by the proximity to the source, this could result in localized increases in wildlife-related coliforms relative to existing conditions and the No Action Alternative NT and LLT. The Delta currently supports similar habitat types and, with the exception of the Clean Water Act section 303(d) listing for the Stockton Deep

Water Ship Channel, is not recognized as exhibiting pathogen concentrations that rise to the level of adversely affecting beneficial uses. As such, the potential increase in wildlife-related coliform concentrations due to tidal habitat creation is not expected to adversely affect beneficial uses.

CM19, which would fund projects to contribute to reducing pollutant discharges in stormwater, would be expected to reduce pathogen load relative to existing conditions and the No Action Alternative NT and LLT. The remaining conservation measures would not be expected to affect pathogen levels, because they are actions that do not affect the presence of pathogen sources.

***CEQA Conclusion*:** It is expected that the pathogen levels in the Delta waters due to implementation of Alternative 1A conservation measures would not be substantially different relative to existing conditions. Therefore, this alternative is not expected to cause additional exceedance of applicable water quality objectives by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. Because pathogen concentrations are not expected to increase substantially, no long-term water quality degradation for pathogens is expected to occur and, thus, no adverse effects on beneficial uses would occur. The San Joaquin River in the Stockton Deep Water Ship Channel is Clean Water Act section 303(d) listed for pathogens. Because no measurable increase in Deep Water Ship Channel pathogen concentrations are expected to occur on a long-term basis, further degradation and impairment of this area is not expected to occur. Finally, pathogens are not bioaccumulative constituents. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-21: Effects on pesticide concentrations resulting from facilities operations and maintenance (CM1)

Upstream of the Delta

For the same reasons stated for the No Action Alternative LLT, under Alternative 1A LLT no specific operations or maintenance activity of the SWP or CVP would substantially drive a change in pesticide use, and thus pesticide sources would remain unaffected upstream of the Delta. Nevertheless, changes in the timing and magnitude of reservoir releases could have an effect on available dilution capacity along river segments such as the Sacramento, Feather, American, and San Joaquin Rivers.

Under Alternative 1A LLT, winter (November–March) and summer (April–October) season average flow rates on the Sacramento River at Freeport, American River at Nimbus, Feather River at Thermalito and the San Joaquin River at Vernalis would change. Averaged over the entire period of record, seasonal average flow rates on the Sacramento would decrease no more than 7% during the summer and 2% during the winter relative to existing conditions (Appendix 8L, Seasonal average flows Tables 1-4). On the Feather River, average flow rates would decrease by as much as 5% during the summer, but would increase by as much as 12% in the winter, while on the American River average flow rates would decrease by as much as 16% in the summer but would increase by as much as 9% in the winter. Seasonal average flow rates on the San Joaquin River would decrease by as much as 12% in the summer, but increase by as much as 1% in the winter relative to existing conditions. In comparison to No Action Alternative NT and No Action Alternative LLT, the relative magnitude change in seasonal average flows would be similar, with exception to the estimated change on the American River and San Joaquin River relative to No ActionAlternative LLT. In comparison to No Action Alternative LLT, there would be no estimated change in season average flows on the San Joaquin River (i.e., 0% summer and winter change) and there would only be a 1% decrease of summer average flows on the American River.

For the same reasons stated for the No Action Alternative LLT, decreased seasonal average flow of ≤16% is not considered to be of sufficient magnitude to substantially increase pesticide concentrations or alter the long-term risk of pesticide-related toxicity to aquatic life, nor adversely affect other beneficial uses of water bodies upstream of the Delta.

Delta

Sources of diuron, OP and pyrethroid insecticides to the Plan Area include direct input of surface runoff from in-Delta agriculture and Delta urbanized areas as well inputs from rivers upstream of the Delta. Similar to Upstream of the Delta, CVP/SWP operations would not affect these sources.

Under Alternative 1A LLT, the distribution and mixing of Delta source waters would change. Percent change in monthly average source water fraction were evaluated for the modeled 16-year (1976-1991) hydrologic period and a representative drought period (1987-1991), with special attention given to changes in San Joaquin River, Sacramento River and Delta Agriculture sources water fractions. Relative to existing conditions, under Alternative 1A LLT modeled San Joaquin River fractions would increase greater than 10% at Franks Tract, Rock Slough, and Contra Costa PP No. 1 (Appendix 8D, Source Water Fingerprinting). At Franks Tract, source water fractions when modeled for the 16-year hydrologic period would increase 13-15% during February and March. San Joaquin River source water fractions when modeled for the 16-year hydrologic period would increase 14-16% during February and March at Rock Slough and 13-17% during March and April at Contra Costa PP No. 1. Sacramento River fractions would increase greater than 10% at Buckley Cove as well. At Buckley Cove, Sacramento River source water fractions when modeled for the 16-year hydrologic period would increase by 11% during August, and 11-14% during July and August during the modeled drought period. Relative to existing conditions, there would be no modeled increases in Delta agricultural fractions greater than 7%. These modeled changes in the source water fractions of Sacramento, San Joaquin and Delta agriculture water are not of sufficient magnitude to substantially alter the long-term risk of pesticide-related toxicity to aquatic life, nor adversely affect other beneficial uses of the Delta.

When compared to No Action Alternative NT and No Action Alternative LLT, changes in source water fractions would be similar in season, geographic extent, and magnitude to those discussed for existing conditions with exception to Buckley Cove. At Buckley Cove, modeled drought period San Joaquin River fractions would increase 15% in July and 26% in August when compared to No Action Alternative LLT(Appendix 8D, Source Water Fingerprinting). These increases would primarily balance through decreases in Sacramento River water and eastsidetributary waters. Nevertheless, the San Joaquin River would only account for 37% of the total source water volume at Buckley Cove in July and August during the modeled drought period. As such, these modeled changes in the source water fractions of Sacramento, San Joaquin and Delta agriculture water are not of sufficient magnitude to substantially alter the long-term risk of pesticide-related toxicity to aquatic life, nor adversely affect other beneficial uses of the Delta.

SWP/CVP Export Service Areas

Assessment of effects in SWP/CVP Export Service Areas is based on effects seen in the Plan Area at the Banks and Jones pumping plants. Under Alternative 1A LLT, Sacramento River source water fractions would increase substantially at both Banks and Jones pumping plants relative to existing conditions, No Action Alternative NT and No Action Alternative LLT (Appendix 8D, Source Water Fingerprinting). Source water fractions would generally increase from 13-53% for the period of December through June for the modeled 16-year hydrologic period and 13-40% from the period of March through May for the modeled drought period. These increases in Sacramento source water fraction would primarily balance through equivalent decreases in San Joaquin River fraction. Based on the general observation that San Joaquin River, in comparison to the Sacramento River, is a greater contributor of OP insecticides in terms of greater frequency of incidence and presence at concentrations exceeding water quality benchmarks, modeled increases in Sacramento River fraction at Banks and Jones would generally represent an improvement in export water quality respective to pesticides.

CEQA Conclusion: Relative to existing conditions, the Alternative 1A LLT would not result in any substantial change in long-term average pesticide concentration or result in substantial increase in the anticipated frequency with which long-term average pesticide concentrations would exceed aquatic life toxicity thresholds or other beneficial use effect thresholds upstream of the Delta, at the 11 assessment locations analyzed for the Delta, or the SWP/CVP service area. Numerous pesticides are currently used throughout the affected environment, and while some of these pesticides may be bioaccumulative, those present-use pesticides for which there is sufficient evidence for their presence in waters affected by SWP and CVP operations (i.e., diazinon, chlorpyrifos, diuron, and pyrethroids) are not considered bioaccumulative, and thus changes in their concentrations would not directly cause bioaccumulative problems in aquatic life or humans. Furthermore, while there are numerous 303(d) listings throughout the affected environment that name pesticides as the cause for beneficial use impairment, the modeled changes in upstream river flows and Delta source water fractions would not be expected to make any of these beneficial use impairments measurably worse. Because long-term average pesticide concentrations are not expected to increase substantially, no long-term water quality degradation with respect to pesticides is expected to occur and, thus, no adverse effects on beneficial uses would occur. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-22: Effects on pesticide concentrations resulting from implementation of CM2–CM22

With the exception of CM13, the mostly non-land disturbing CM12–CM22 present no new sources of pesticides to the affected environment, including areas Upstream of the Delta, within the Plan Area, and the SWP/ CVP Export Service Area. Implementation of urban stormwater treatment measures (CM19) may result in beneficial effects, to the extent that control measures treat or reduce pesticide loading from urban land uses. However, control of nonnative aquatic vegetation (CM13) associated with tidal habitat restoration efforts would include killing invasive and nuisance aquatic vegetation through direct application of herbicides or through alternative mechanical means. Use and selection of type of herbicides would largely be circumstance specific, but would follow existing control methods used by the California Department of Boating and Waterways (CDBW). The CDBW's use of herbicides is regulated by permits and regulatory agreements with the Central Valley Regional Water Quality Control Board, US Fish and Wildlife Service, and National Marine Fisheries Service and is guided by research conducted on the efficacy of vegetation control in the Delta through herbicide use. Through a program of adaptive management and assessment, the CDBW has employed a program of herbicide use that reduces potential environmental impacts, nevertheless, the CDBW found that impacts on water quality and associated aquatic beneficial uses would continue to occur and could not be avoided, including non-target impacts on aquatic invertebrates and beneficial aquatic plants (California Department of Boating and Waterways 2006).

In addition to the potential beneficial and adverse effects of CM19 and CM13, respectively, the various restoration efforts of CM2–CM11 could involve the conversion of active or fallow agricultural lands to natural landscapes, such as wetlands, grasslands, floodplains, and vernal pools. In the long-term, conversion of agricultural land to natural landscapes could possibly result in a limited reduction in pesticide use throughout the Delta. In the short-term, tidal and non-tidal wetland restoration, as well as seasonal floodplain restoration (i.e., CM4, CM5, and CM10) over former agricultural lands may include the contamination of water with pesticides residues contained in the soils. Present use pesticides typically degrade fairly rapidly, and in such cases where pesticide containing soils are flooded, dissipation of those pesticides would be expected to occur rapidly. Moreover, seasonal floodplain restoration (CM5) and Yolo Bypass enhancements (CM2) may be managed alongside continuing agriculture, where pesticides may be used on a seasonal basis and where water during flood events may come in contact with residues of these pesticides. Similarly, however, rapid dissipation would be expected, particularly in the large volumes of water involved in flooding. During these flooding events, pesticides potentially suspended in water would not be expected to cause toxicity to aquatic life or cause substantial adverse effects on any other beneficial uses of these water bodies.

CEQA Conclusion: With the exception of CM13, implementation of CM2–CM22 would not present new or substantially increased sources of pesticides in the Plan Area. In the long-term, implementation of conservation measures could possibly result in a limited reduction in pesticide use throughout the Delta through the potential repurposing of active or fallow agricultural land for natural habitat purposes. In the short-term, the repurposing of agricultural land associated with CM4, CM5, and CM10 may expose water used for habitat restoration to pesticide residues. Moreover, CM2 and CM5 may be managed alongside continuing agriculture, where pesticides may be used on a seasonal basis and where water during flood events may come in contact with residues of these pesticides. However, rapid dissipation would be expected, particularly in the large volumes of water involved in flooding, such that aquatic life toxicity objectives would not be exceeded by frequency, magnitude, and geographic extent whereby adverse effectson beneficial uses would be expected. Conservation measures CM2–CM22 do not include the use of pesticides known to be bioaccumulative in animals or humans, nor do the conservation measures propose the use of any pesticide currently named in a Section 303(d) listing of the affected environment. CM13 proposes the use of herbicides to control invasive aquatic vegetation around habitat restoration sites. Herbicides directly applied to water could include adverse effects on non-target aquatic life, such as aquatic invertebrates and beneficial aquatic plants. As such, aquatic life toxicity objectives could be exceeded with sufficient frequency and magnitude such that beneficial uses would be impacted. Potential environmental effects related only to CM13 are considered significant and unavoidable. Mitigation Measure WQ-22 is available to partially reduce this impact of pesticides on water quality; however, no feasible mitigation is available that would reduce it to a level that would be less than significant.

Mitigation Measure WQ-22: Implement least toxic integrated pest management strategies

Implement the "least toxic" principals of integrated pest management (IPM) in the management of invasive aquatic vegetation under CM13. In doing so, the BDCP proponents will consult with the Central Valley Water Board, USFWS, NMFS, and CDBW to obtain effective IPM strategies such as efficacious but least toxic active ingredients, timing of applications in order to minimize tidal dispersion and timing to target the invasive plant species at the most vulnerable times such that less herbicide can be used or the need for repeat applications can be reduced.

Impact WQ-23: Effects on phosphorus concentrations resulting from facilities operations and maintenance (CM1)

Upstream of the Delta

The conveyance facilities operations and maintenance (CM 1) for Alternative 1A LLT will not contribute additional sources of phosphorus to the water bodies upstream of the Delta. Because phosphorus loading to waters upstream of the Delta is not anticipated to change under Alternative 1A LLT, and because changes in flows do not necessarily result in changes in concentrations or loading of phosphorus to these water bodies, as discussed for the No Action Alternative, substantial changes in phosphorus concentration are not anticipated in any of the water bodies of the affected environment located upstream of the Delta under Alternative 1A LLT, relative to existing conditions, No Action NT, or No Action LLT. Any negligible changes in phosphorus concentrations that may occur in these water bodies would not be of frequency, magnitude and geographic extent that would exceed adopted phosphorus objectives/criteria (because there are none), adversely affect any beneficial uses, or substantially degrade the quality of these water bodies, with regards to phosphorus.

Delta

As discussed for the No Action Alternative, because phosphorus concentrations in the major source waters to the Delta are similar for much of the year, phosphorus concentrations in the Delta are not anticipated to change substantially on a long term-average basis. Additionally, activities associated with CM1 will not contribute additional sources of phosphorus to the Delta. Phosphorus concentrations may increase during January through March at locations where the source fraction of San Joaquin River water increases, due to the higher concentration of phosphorus in the San Joaquin River during these months compared to Sacramento River water or San Francisco Bay water. Based on the DSM2 fingerprinting results (see Appendix D), together with source water concentrations show in Figure 60, the magnitude of increase during these months may range from negligible up to approximately 0.05 mg/L. However, there are no state or federal objectives for phosphorus, and because algal growth rates are limited by availability of light in the Delta, and thus increases or decreases in nutrient levels are, in general, expected to have little effect on productivity, any changes in phosphorus concentrations that may occur at certain locations within the Delta are not anticipated to be of frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the water quality at these locations, with regards to phosphorus.

SWP/CVP Export Service Areas

Assessment of effects of phosphorus in the SWP and CVP Export Service Areas is based on effects on phosphorus at the Banks and Jones pumping plants.

Based on the DSM2 fingerprinting results (see Appendix D), together with source water concentrations show in Figure 60, long-term average monthly and annual phosphorus concentrations at Banks and Jones pumping plants are anticipated to decrease as a result of Sacramento River water replacing San Joaquin River water in exports. During drought conditions, phosphorus concentrations may increase during certain months, but these increases are expected to be neglible (<0.01 mg/L). There are no state or federal objectives for phosphorus. Moreover, given the many factors that contribute to potential algal blooms in the SWP and CVP canals within the Export Service Area, and the lack of studies that have shown a direct relationship between nutrient concentrations in the canals and reservoirs and problematic algal blooms in these water bodies, there is no basis to conclude that any seasonal increases in phosphorus concentrations at the levels expected under this alternative, should they occur, would increase the potential for problem algal blooms in the SWP and CVP Export Service Area.

Any increases in phosphorus concentrations that may occur in water exported via Banks and Jones pumping plants are not expected to result in adverse effects to beneficial uses of exported water or substantially degrade the quality of exported water, with regards to phosphorus.

CEQA Conclusion: There would be no substantial, long-term increase in phosphorus concentrations in the rivers and reservoirs upstream of the Delta, in the Delta Region, or the waters exported to the CVP and SWP service areas under the Alternative 1A LLT relative to existing conditions. As such, this alternative is not expected to cause additional exceedance of applicable water quality objectives/criteria by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. Because phosphorus concentrations are not expected to increase substantially, no long-term water quality degradation is expected to occur and, thus, no adverse effects to beneficial uses would occur. Phosphorus is not 303(d) listed within the affected environment and thus any minor increases than may occur in some areas would not make any existing phosphorus-related impairment measurably worse because no such impairments currently exist. Because phosphorus is not bioaccumulative, minor increases that may occur in some areas would not bioaccumulate to greater levels in aquatic organisms that would, in turn, pose substantial health risks to fish, wildlife, or humans. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-24: Effects on phosphorus concentrations resulting from implementation of CM2–CM22

CM2–CM11 include activities that create additional aquatic habitat within the affected environment, and therefore may increase the total amount of algae and plant-life within the Delta. These activities would not affect phosphorus loading to the affected environment, but may affect phosphorus dynamics and speciation. For example, water column concentrations of total phosphorus may increase or decrease in localized areas as a result of increased or decreased suspended solids, while orthophosphate concentrations may be locally altered as a result of changing planktonic and macroinvertebrate species contributing to the cycling of phosphorus within the affected environment. Additionally, depending on age, configuration, location, operation, and season, some of the restoration measures included under these conservation measures may function to remove or sequester phosphorus, but since presently, the specific design, operational criteria, and location of these activities are not well established, the degree to which this would occur is unknown. Overall, phosphorus concentrations are not expected to change substantially in the affected environment as a result of CM2–CM22. Because increases or decreases in phosphorus levels are, in general, expected to have little effect on productivity, any changes in phosphorus concentrations that may occur at certain locations within the affected environment are not anticipated to be of frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the water quality at these locations, with regards to phosphorus.

Because urban stormwater is a source of phosphorus in the affected environment, conservation measure CM19, Urban Stormwater Treatment, is expected to slightly reduce phosphorus loading to the Delta, thus slightly decreasing phosphorus concentrations relative to existing conditions and the

No Action Alternative. Implementation of CM12–CM18 and CM20–CM22 is not expected to substantially alter phosphorus concentrations in the affected environment.

***CEQA Conclusion*:** There would be no substantial, long-term increase in phosphorus concentrations in the rivers and reservoirs upstream of the Delta, in the Delta Region, or the waters exported to the CVP and SWP service areas due to implementation of CM2–CM22 under Alternative 1A LLT relative to existing conditions. Because urban stormwater is a source of phosphorus in the affected environment, conservation measure CM19, Urban Stormwater Treatment, is expected to slightly reduce phosphorus loading to the Delta. As such, implementation of these conservation measures is not expected to cause adverse effects on any beneficial uses of waters in the affected environment. Because phosphorus concentrations are not expected to increase substantially due to these conservation measures, no long-term water quality degradation is expected to occur and, thus, no adverse effects to beneficial uses would occur. Phosphorus is not 303(d) listed within the affected environment and thus any minor increases than may occur in some areas would not make any existing phosphorus-related impairment measurably worse because no such impairments currently exist. Because phosphorus is not bioaccumulative, minor increases that may occur in some areas would not bioaccumulate to greater levels in aquatic organisms that would, in turn, pose substantial health risks to fish, wildlife, or humans. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-25: Effects on selenium concentrations resulting from facilities operations and maintenance (CM1)

[*Note to Lead Agencies: This assessment is in preparation*].

Impact WQ-26: Effects on selenium concentrations resulting from implementation of CM2–CM22

[*Note to Lead Agencies: This assessment is in preparation*].

Impact WQ-27: Effects on trace metal concentrations resulting from facilities operations and maintenance (CM1)

Upstream of the Delta

For the same reasons stated for the No Action Alternative LLT, Alternative 1A LLT would result in negligible, and likely immeasurable, increases in trace metal concentrations in the rivers and reservoirs upstream of the Delta, relative to existing conditions, No Action NT and No Action LLT. Effects due to the operation and maintenance of the conveyance facilities are expected to be immeasurable, on an annual and long-term average basis. As such, the Alternative 1A would not be expected to substantially increase the frequency with which applicable Basin Plan objectives or CTR criteria would be exceeded in water bodies of the affected environment located upstream of the Delta or substantially degrade the quality of these water bodies, with regard to trace metals.

Delta

For the same reasons stated for the No Action Alternative LLT, Alternative 1A LLT would not result in substantial increases in trace metal concentrations in the Delta relative to existing conditions, No Action NT, and No Action LLT. Effects due to the operation and maintenance of the conveyance facilities are expected to be negligible, on long-term average basis. As such, Alternative 1A would not be expected to substantially increase the frequency with which applicable Basin Plan objectives or CTR criteria would be exceeded in the Delta or substantially degrade the quality of Delta waters, with regard to trace metals.

SWP/CVP Export Service Areas

For the same reasons stated for the No Action Alternative LLT, Alternative 1A LLT would not result in substantial increases in trace metal concentrations in the water exported from the Delta or diverted from the Sacramento River through the proposed conveyance facilities. As such, there is not expected to be substantial changes in trace metal concentrations in the SWP/CVP export service area waters under Alternative 1A, relative to existing conditions, No Action NT, and No Action LLT. As such, Alternative 1A would not be expected to substantially increase the frequency with which applicable Basin Plan objectives or CTR criteria would be exceeded in the water bodies of the affected environment in the SWP and CVP Service Area or substantially degrade the quality of these water bodies, with regard to trace metals.

***CEQA Conclusion*:** There would be no substantial long-term increase in trace metal concentrations in the rivers and reservoirs upstream of the Delta, in the Delta Region, or the SWP/CVP export service area waters under Alternative 1A relative to existing conditions. As such, this alternative is not expected to cause additional exceedance of applicable water quality objectives by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. Because trace metal concentrations are not expected to increase substantially, no long-term water quality degradation for trace metals is expected to occur and, thus, no adverse effects to beneficial uses would occur. Furthermore, any negligible changes in long-term trace metal concentrations that may occur in water bodies of the affected environment would not be expected to make any existing beneficial use impairments measurably worse. The trace metals discussed in this assessment are not considered bioaccumulative, and thus would not directly cause bioaccumulative problems in aquatic life or humans. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-28: Effects on trace metal concentrations resulting from implementation of CM2–CM22

Implementation of CM2-CM22 present no new sources of trace metals to the affected environment, including areas upstream of the Delta, within the Delta, or in the SWP and CVP service areas. However, CM19, which would fund projects to contribute to reducing pollutant discharges in stormwater, would be expected to reduce trace metal loading to surface waters of the affected environment. The remaining conservation measures would not be expected to affect trace metal levels, because they are actions that do not affect the presence of trace metal sources. As they pertain to trace metals, implementation of these conservation measures would not be expected to adversely affect beneficial uses of the affected environment or substantially degrade water quality with respect to trace metals.

CEQA Conclusion: Implementation of CM2–CM22 under Alternative 1A would not cause substantial long-term increase in trace metal concentrations in the rivers and reservoirs upstream of the Delta, in the Delta Region, or the SWP/CVP export service area. As such, this alternative is not expected to cause additional exceedance of applicable water quality objectives by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. Because trace metal concentrations are not expected to increase substantially, no long-term water quality degradation for trace metals is expected to occur and, thus, no adverse effects to beneficial uses would occur. Furthermore, any negligible changes in long-term trace metal concentrations that may occur throughout the affected environment would not be expected to make any existing beneficial use impairments measurably worse. The trace metals discussed in this assessment are not considered bioaccumulative, and thus would not directly cause bioaccumulative problems in aquatic life or humans. This impact is considered to be less than significant. No mitigation is required.

ImpactWQ-29: Effects on TSS and turbidity resulting from facilities operations and maintenance (CM1)

Upstream of the Delta

For the same reasons stated for the No Action Alternative LLT, Alternative 1A LLT is expected to have minimal effect on TSS concentrations and turbidity levels (highs, lows, typical conditions) in reservoirs and rivers upstream of the Delta relative to existing conditions and the No Action Alternative NT and LLT. Any minor increases in TSS concentrations and turbidity levels that may occur under Alternative 1A LLT would not be of sufficient frequency, magnitude, and geographic extent that would result in adverse effects on beneficial uses within the Upstream of the Delta Region,or substantially degrade the quality of these water bodies, with regard to TSS and turbidity.

Delta

The TSS concentrations and turbidity levels of Delta inflows under Alternative 1A LLT are not expected to be substantially different from those occurring under existing conditions or would occur under the No Action Alternative NT and LLT. However, the implementation of this alternative would change the quantity of Delta inflows, which would affect Delta hydrodynamics and, thus, erosion and deposition potential in certain Delta channels. Localized changes in TSS concentrations and turbidity levels could occur, depending on how rapidly the Delta hydrodynamics are altered and the channels equilibrate with the new tidal flux regime, after implementation of this alternative. The magnitude of increases in TSS concentrations and turbidity levels in the affected channels due to higher potential of erosion cannot be readily quantified. However, geomorphic changes associated with sediment transport and deposition are usually gradual, occurring over years. Once the channels are reconfigured, it is expected that the TSS concentrations and turbidity levels in the affected channels would not be substantially different from the levels under existing conditions or the No Action Alternative NT and LLT. Consequently, any notable increases in TSS concentrations and turbidity levels that may occur under Alternative 1A LLT would likely be short-term in nature and long-term changes under this alternative would not be of sufficient frequency, magnitude and geographic extent that would result in adverse effects on beneficial uses in the Delta region, or substantially degrade the quality of these water bodies, with regard to TSS and turbidity.

SWP/CVP Export Service Areas

The water delivered to the SWP/CVP Export Service Areas would differ from that under existing conditions and the No Action Alternative NT and LLT, as it would consist of water diverted directly from the Sacramento River at Hood in addition to water withdrawn from the Delta at the current export pumps. Historical median turbidity levels in the Sacramento River at Hood (11 NTU) and in the Delta waters at the Harvey O. Banks Pumping Plant Headworks (11 NTU) are similar (Figure 8-## Delta showing mean/median turbidity levels Unique ID HDR0135) and mean turbidity levels differ by 5 NTU (13 NTU at Banks pumping plant and 18 NTU in the Sacramento River at Hood).

Thus, it is expected that the TSS concentrations and turbidity levels in the vicinity of the south Delta export pumps would not be substantially different from the levels under the existing conditions or the No Action Alternative NT and LLT. Consequently, the increases in TSS concentrations and turbidity levels that may occur under Alternative 1A LLT would not be of sufficient frequency, magnitude, and geographic extent that would result in adverse effects on beneficial uses within the SWP/CVP Export Service Areas or substantially degrade the quality of these water bodies, with regard to TSS and turbidity.

CEQA Conclusion: It is expected that the TSS concentrations and turbidity levels Upstream of the Delta, in the Plan Area, and the SWP/CVP Export Service Areas due to implementation of CM1 (water facilities and operations) would not be substantially different under Alternative 1A LLT relative to existing conditions. Therefore, this alternative is not expected to cause additional exceedance of applicable water quality objectives where such objectives are not exceeded under existing conditions. Because TSS concentrations and turbidity levels are not expected to be substantially different, long-term water quality degradation is not expected, and, thus, beneficial uses are not expected to be adversely affected. Finally, TSS and turbidity are neither bioaccumulative nor Clean Water Act section 303(d) listed constituents. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-30: Effects on TSS and turbidity resulting from implementation of CM2–CM22

Creation of habitat and open water through implementation of CM2–CM11 could affect Delta hydrodynamics and, thus, erosion and deposition potential in certain Delta channels. The magnitude of increases in TSS concentrations and turbidity levels in the affected channels due to higher potential of erosion cannot be readily quantified. The increases in TSS concentrations and turbidity levels in the affected channels could be substantial in localized areas, depending on how rapidly the Delta hydrodynamics are altered and the channels equilibrate with the new tidal flux regime, after implementation of this alternative. However, geomorphic changes associated with sediment transport and deposition are usually gradual, occurring over years. Once the channels are reconfigured, it is expected that the TSS concentrations and turbidity levels in the affected channels would not be substantially different from the levels under existing conditions or the No Action Alternative NT and LLT.

CM19, which would fund projects to contribute to reducing pollutant discharges in stormwater, would be expected to reduce TSS and turbidity in urban discharges relative to existing conditions and the No Action Alternative NT and LLT. The remaining conservation measures would not be expected to affect TSS concentrations and turbidity levels, because they are actions that do not affect the presence of TSS and turbidity sources.

CEQA Conclusion: It is expected that the TSS concentrations and turbidity levels Upstream of the Delta, in the Plan Area, and the SWP/CVP Export Service Areas due to implementation of CM2–CM22 under Alternative 1A would not be substantially different relative to existing conditions. Therefore, this alternative is not expected to cause additional exceedance of applicable water quality objectives where such objectives are not exceeded under existing conditions. Because TSS concentrations and turbidity levels are not expected to be substantially different, long-term water quality degradation is not expected relative to TSS and turbidity, and, thus, beneficial uses are not expected to be adversely affected. Finally, TSS and turbidity are neither bioaccumulative nor Clean Water Act section 303(d) listed constituents. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-31: Water quality effects resulting from construction-related activities

This section addresses construction-related water quality effects to constituents of concern other than effects caused by changes in the operations and maintenance of CM1–CM22, which are addressed in terms of constituent-specific impact assessments elsewhere in this chapter. Under Alternative 1A LLT, the majority of construction-related activities for conservation measures CM1-CM22 would occur within the Delta. Few, if any, of the CM1–CM22 actions involve construction work in the SWP and CVP Service Area or areas upstream of the Delta. The conservation measures, or components of measures, that are anticipated to be constructed in areas upstream of the Delta would be limited to: (1) the Yolo Bypass Fishery Enhancement (CM2) (i.e., the Fremont Weir component of the action), (2) Conservation Hatcheries (CM18) (i.e., the new hatchery facility), and (3) Urban Stormwater Treatment (CM19).

Within the Delta, the construction-related activities for Alternative 1A LLT would be most extensive for CM1 involving the new water conveyance facilities. Habitat restoration activities in the Delta (i.e., CM4–CM10), including restored tidal wetlands, floodplain, and related channel margin and off-channel habitats, also would involve substantial construction-related activities across widespread areas of the Delta. Construction activities also would occur for CM2 in the Yolo Bypass to implement fish enhancement features. Anticipated construction activities that may occur under CM11–CM22, if any, would involve relatively minor disturbances, and thus would not be anticipated to result in substantial discharges of any constituents of concern.

The extensive construction activities that will be necessary to implement CM1, CM2, and CM4–CM10 would involve a variety of land disturbances in the Delta including vegetation removal; grading and excavation of soils; establishment of roads-bridges, staging, and storage areas; in-water sediment dredging and dredge material disposal; and hauling and placement or disposal of excavated soils and dredge materials. The types of potential construction-related water quality effects associated with implementation of conservation measures CM1–CM22 under Alternative 1A would be very similar to the effects discussed above for the No Action Alternative LLT. However, relative to existing conditions and the No Action Alternative conditions, these additional major land and in-water disturbances and related site development activities would be anticipated to increase the potential to cause direct discharges and stormwater runoff of sediment to adjacent water bodies, particularly during the rainy season (generally October to April in California). In particular, the construction of the intakes and tunnel system for CM1 under Alternative 1A LLT would involve extensive general construction activities, material handling/storage/placement operations, concrete operations associated with tunnel construction, bored sediment disposal activities, and construction site dewatering. Additionally, new grading and excavation activities, or exposure of disturbed sites immediately following construction and prior to stabilization, could result in rainfall- and stormwater-related soil erosion, runoff, and offsite sedimentation in surface water bodies. The initial runoff following construction, or return of seasonal rains to previously disturbed sites, can result in runoff with peak pollutant levels and is referred to as "first flush" storm events. Soil erosion and runoff can also result in increased concentrations and loading of organic matter, nutrients (nitrogen and phosphorus), and other contaminants contained in the soil such as trace metals, pesticides, or animal-related pathogens. Graded and exposed soils also can be compacted by heavy machinery, resulting in reduced infiltration of rainfall and runoff, thus increasing the rate of runoff (and hence contaminants) to downstream water bodies.

Construction activities also would be anticipated to involve the transport, handling, and use of a variety of hazardous substances and non-hazardous materials that may adversely affect water quality if discharged inadvertently to construction sites or directly to water bodies. Typical construction-related contaminants include petroleum products for refueling and maintenance of machinery (e.g., fuel, oils, solvents), concrete, paints and other coatings, cleaning agents, debris and trash, and human wastes. Construction activities also would involve large material storage and laydown areas, and occasional accidental spills of hazardous materials stored and used for construction may occur. Contaminants released or spilled on bare soil also may result in groundwater contamination. Construction would involve extensive excavation/trenching and other subsurface construction activities, trenching, or work in or near Delta channels requiring site-dewatering operations to isolate the construction site from surface and groundwater. Dewatering operations may contain elevated levels of suspended sediment or other constituents that may cause water quality degradation.

The intensity of construction activity along with the fate and transport characteristics of the chemicals used at site, would largely determine the magnitude, duration, and frequency of construction-related discharges and resulting concentrations and degradation associated with the specific constituents of concern. The potential water quality concerns associated with the major categories of contaminants that might be discharged as a result of construction activity include the following.

- Suspended sediment: May increase turbidity (i.e., reduce water clarity) that can affect aquatic organisms and increase the costs and effort of removal in municipal/industrial water supplies. Downstream sedimentation can affect aquatic habitat, or cause a nuisance if it affects functions of agricultural or municipal intakes, or boat navigation.
- Organic matter: May contribute turbidity and oxygen demanding substances (i.e., reduce dissolved oxygen levels) that can affect aquatic organisms. Organic carbon may increase the potential for disinfection byproduct formation in municipal drinking water supplies.
- Nutrients: May contribute nitrogen, phosphorus, and other key nutrients that can contribute to nuisance biostimulation of algae and vascular aquatic plants, which may affect municipal water supplies, recreation, aquatic life, and aesthetics.
- Petroleum hydrocarbons: May contribute toxic compounds to aquatic life, and oily sheens may reduce oxygen/gas transfer in water, foul aquatic habitats, and reduce water quality for municipal supplies, recreation, and aesthetics.
- Trace constituents (metals, pesticides, synthetic organic compounds): Compounds in eroded soil or construction-related materials (e.g., paints, coatings, cleaning agents) may be toxic to aquatic life.
- Pathogens: Bacteria, viruses, and protozoans may affect aquatic life and increase human health risks via municipal water supplies, reduced recreational water quality, or contaminated shellfish beds.
- Other inorganic compounds: Construction-related materials can contain inorganic compounds such as acidic/basic materials which can change pH and may adversely affect aquatic life and habitats. Concrete contains lime which can increase pH levels, and drilling fluids may alter pH.

Construction-related activities may contribute to the discharge of contaminants such as PAHs which may be bioaccumulative in aquatic organisms, and construction-related disturbances may contribute to discharge of contaminants in soils and sediments in the Delta that are associated with existing impairments identified for Delta water bodies on the state's Section 303(d) list. However, intermittent and temporary construction-related activities would not be anticipated to result in contaminant discharges of substantial magnitude or duration to contribute to long-term bioaccumulation processes, or cause measureable long-term degradation such that existing 303(d) impairments would be made discernibly worse or TMDL actions to reduce loading would be adversely affected.

For the purposes of this assessment, it is assumed that construction activities conducted for Alternative 1A LLT would be conducted in conformance to applicable federal, state, and local agency regulations pertaining to grading and erosion control, and contaminant spill control and response measures. Additionally, the implementation of construction-related environmental commitments would be specifically designed and implemented for Alternative 1A LLT to avoid, prevent, and minimize the potential discharges of constituents of concern to water bodies and associated adverse water quality effects.

In particular, construction-related activities under Alternative 1A LLT would be conducted in accordance with the environmental commitment to obtain authorization for all applicable construction activities under the State Water Board's NPDES Stormwater General Permit for Stormwater Discharges Associated with Construction and Land Disturbance Activities (Order No. 2009-0009-DWQ/NPDES Permit No. CAS000002). This General Construction NPDES Permit requires the preparation and implementation of a Stormwater Pollution Prevention Plan (SWPPP) that identifies the proposed erosion control and pollution prevention BMPs that would be used to avoid and minimize construction-related erosion and contaminant discharges. In addition to the BMPs, the SWPPP would include BMP inspection and monitoring activities, and identify responsibilities of all parties, contingency measures, agency contacts, and training requirements and documentation for those personnel responsible for installation, inspection, maintenance, and repair of BMPs. The BMPs that are routinely implemented in the construction industry and have proven successful at reducing adverse water quality effects include:

- Pollution Prevention: Identification of all construction sites and staging areas; work schedules; temporary soil storage and borrow areas; construction materials handling and disposal; site-dewatering and treatment activities and discharge locations; and final stabilization and clean-up measures.
- Erosion Control: BMPs designed to stabilize exposed soils; minimize offsite sediment runoff; remove sediment from onsite runoff before it leaves the site; and slow runoff rates across construction sites. Identification of appropriate temporary and long-term seeding, mulching, and other erosion control measures as necessary.
- Good Housekeeping Measures: Identification of measures designed to reduce exposure of construction sites and materials storage to stormwater runoff including truck tire tracking control facilities; equipment washing; litter and construction debris; designated refueling and equipment inspection/maintenance practices; and, hazardous material storage and handling, and spill control and response measures.
- BMP Inspection and Monitoring: Identification of clear objectives for evaluating compliance with SWPPP provisions, and specific BMP inspection and monitoring procedures, environmental awareness training, contractor and agency roles and responsibilities, reporting procedures, and communication protocols.

The potential construction-related contaminant discharges that could result from projects defined under Alternative 1A LLT would not be anticipated to result in adverse water quality effects at a magnitude, frequency, or regional extent that would cause substantial adverse effects to aquatic life. Relative to existing conditions, this assessment indicates the following.

- Projects would be managed under state and local water quality regulations and project-defined actions to avoid and minimize contaminant discharges.
- Individual projects would generally be dispersed, and involve infrequent and temporary activities, thus not likely resulting in substantial exceedances of water quality standards or long-term degradation.
- Potential construction-related contaminant discharges under the Alternative 1A LLT would not cause additional exceedance of applicable water quality objectives where such objectives are not exceeded under existing conditions. Long-term water quality degradation is not anticipated, and hence would not be expected to adversely affect beneficial uses.

Additionally, the environmental commitments (Appendix 3B, *Environmental Commitments* [*in development*]) under Alternative 1A would include acquisition of applicable environmental permits identified as necessary for specific conservation measures, which as described for the No Action Alternative, and may include specific WDRs or CWA Section 401 water quality certifications from the appropriate Regional Water Boards, DFG Streambed Alteration Agreements, and USACE CWA Section 404 dredge and fill permits. These other permit processes may include requirements to implement additional action-specific BMPs that may reduce potential adverse discharge effects of constituents of concern. Consequently, because the construction-related activities for the conservation measures would be conducted with implementation of environmental commitments, with respect to the existing conditions and No Action Alternative conditions, Alternative 1A LLT would not be expected to cause constituent discharges of sufficient frequency and magnitude to result in a substantial increase of exceedances of water quality objectives/criteria, or substantially degrade water quality with respect to the constituents of concern, and thus would not adversely affect any beneficial uses in the Delta.

CEQA Conclusion: Construction-related contaminant discharges would be temporary and intermittent in nature and would involve negligible, if any, discharges of bioaccumulative or 303(d) listed constituents to water bodies of the affected environment. As such, construction activities would not contribute measurably to bioaccumulation of contaminants in organisms or humans or cause 303(d) impairments to be discernibly worse. Because environmental commitments would be implemented under Alternative 1A LLT for construction-related activities along with agency-issued permits that also contain construction related mitigation requirements to protect water quality, the construction-related effects would not be expected to cause or contribute to a substantial increased frequency of exceedances of water quality objectives/criteria relative to existing conditions, or substantially degrade water quality with respect to the constituents of concern on a long-term average basis, and thus would not adversely affect any beneficial uses in water bodies upstream of the Delta, within the Delta, or in the SWP and CVP service area. Based on these findings, this impact is determined to be less than significant. No mitigation is required.

8.3.4.3 Alternative 1B—Dual Conveyance with East Canal and Intakes 1–5 (15,000 cfs; Operational Scenario A)

Alternative 1B would be identical to Alternative 1A except that the up to 15,000 cfs of water routed from the north Delta to the south Delta would be conveyed through a canal along the east side of the Delta instead of through pipelines/tunnels. CM2–CM22 would be implemented under this alternative, and these conservation measures would be the same as those under Alternative 1A. See Chapter 3, *Description of Alternatives*, for additional details on Alternative 1B.

Water Quality Effects Resulting from Facilities Operations and Maintenance (CM1)

Alternative 1B has the same diversion and conveyance operations as Alternative 1A. The primary difference between the two alternatives is that conveyance under Alternative 1B would be in a lined or unlined canal, instead of pipeline. Because there would be no difference in conveyance capacity or operations, there would be no differences between these two alternatives in upstream of the Delta river flows or reservoir operations, Delta inflow, source fractions to various Delta locations, and hydrodynamics in the Delta. Conveyance of water in an open channel instead of a pipeline may result in differing physical properties (e.g., DO, pH, temperature) of the water upon reaching the south Delta export pumps than if the water was conveyed in a pipeline. However, the physical properties of water arriving at the south Delta export pumps would continue to change and would equilibrate to similar levels as Alternative 1A as it is conveyed throughout the SWP/CVP Export Service Areas. Because no substantial differences in water quality effects are anticipated anywhere in the affected environment under Alternative 1B compared to those described in detail for Alternative 1A, the water quality effects described for Alternative 1A also appropriately characterize effects under Alternative 1B.

Water Quality Effects Resulting from Implementation of CM2–CM22

Alternative 1B has the same conservation measures as Alternative 1A. Because no substantial differences in water quality effects are anticipated anywhere in the affected environment under Alternative 1B compared to those described in detail for Alternative 1A, the water quality effects described for Alternative 1A also appropriately characterize effects under Alternative 1B.

Water Quality Effects Resulting from Construction-Related Activities for CM1–CM22 Implementation

The primary difference between Alternative 1B and Alternative 1A is that under Alternative 1B, a canal would be constructed for conservation measure CM1 along the eastern side of the Delta to convey the Sacramento River water south, rather than the tunnel/pipeline features. As such, construction techniques and locations of major features of the conveyance system within the Delta would be different. The remainder of the facilities constructed under Alternative 1B, including conservation measures CM2–CM22, would be very similar to, or the same as, those to be constructed for Alternative 1A.

The types of potential construction-related water quality effects associated with implementation of conservation measures CM1 under Alternative 1B would be very similar to the effects discussed for Alternative 1A LLT, and the effects anticipated with implementation of CM2–CM22 would be essentially identical. Given the substantial differences in the conveyance features under CM1 with the construction of a canal, there would be differences in the location, magnitude, duration, and frequency of construction activities and related water quality effects. In particular, relative to the existing conditions and No Action Alternative conditions, construction of the major intakes and canal features for CM1 under Alternative 1B LLT would involve extensive general construction activities, material handling/storage/placement activities, surface soil grading/excavation/disposal and associated exposure of disturbed sites to erosion and runoff, and construction site dewatering operations. Nevertheless, the construction of CM1 with the environmental commitments and agency permitted construction requirements and BMPs would result in the potential water quality effects being largely avoided and minimized. The specific environmental commitments that would be implemented under Alternative 1B would be similar to those described for Alternative 1A for additional information regarding the environmental commitments and environmental permits). Consequently, relative to existing conditions, Alternative 1B LLT would not be expected to cause exceedance of applicable water quality objectives/criteria or substantial water quality degradation with respect to constituents of concern, and thus would not adversely affect any beneficial uses upstream of the Delta, in the Delta, or in the SWP and CVP service area.

8.3.4.4 Alternative 1C—Dual Conveyance with West Canal and Intakes W1–W5 (15,000 cfs; Operational Scenario A)

Alternative 1C would be identical to Alternative 1A except that the up to 15,000 cfs of water routed from the north Delta to the south Delta would be conveyed through a canal/tunnel along the west side of the Delta instead of through pipelines/tunnels. CM2–CM22 would be implemented under this alternative, and these conservation measures would be the same as those under Alternative 1A. See Chapter 3, *Description of Alternatives*, for additional details on Alternative 1C.

Water Quality Effects Resulting from Facilities Operations and Maintenance (CM1)

Alternative 1C has the same diversion and conveyance operations as Alternative 1A. The primary differences between the two alternatives are that conveyance under Alternative 1C would be in a lined or unlined canal, instead of pipeline, and the alignment of the canal would be along the western side of the Delta, rather than the eastern side. Because there would be no difference in conveyance capacity or operations, there would be no differences between these two alternatives in upstream of the Delta river flows or reservoir operations, Delta inflow, source fractions to various Delta locations, and hydrodynamics in the Delta. Conveyance of water in an open channel instead of a pipeline may result in differing physical properties (e.g., DO, pH, temperature) of the water upon reaching the south Delta export pumps than if the water was conveyed in a pipeline. However, the physical properties of water arriving at the south Delta export pumps would continue to change and would equilibrate to similar levels as Alternative 1A as it is conveyed throughout the SWP/CVP Export Service Areas. Because no substantial differences in water quality effects are anticipated anywhere in the affected environment under Alternative 1C compared to those described in detail for Alternative 1A, the water quality effects described for Alternative 1A also appropriately characterize effects under Alternative 1C.

Water Quality Effects Resulting from Implementation of CM2–CM22

Alternative 1C has the same conservation measures as Alternative 1A. Because no substantial differences in water quality effects are anticipated anywhere in the affected environment under Alternative 1C compared to those described in detail for Alternative 1A, the water quality effects described for Alternative 1A also appropriately characterize effects under Alternative 1C.

Water Quality Effects Resulting from Construction-Related Activities for CM1–CM22 Implementation

The primary difference between Alternative 1C and Alternative 1A is that under Alternative 1C, a canal would be constructed for conservation measure CM1 along the western side of the Delta to convey the Sacramento River water south, in addition to similar but shorter tunnel/pipeline features. As such, construction techniques and locations of major features of the conveyance system within the Delta would be different. The remainder of the facilities constructed under Alternative 1C, including conservation measures CM2–CM22, would be very similar to, or the same as, those to be constructed for Alternative 1A.

The types of potential construction-related water quality effects associated with implementation of conservation measures CM1 under Alternative 1C would be very similar to the effects discussed for Alternative 1A LLT, and the effects anticipated with implementation of CM2–CM22 would be essentially identical. Given the substantial differences in the conveyance features under CM1 with construction of canal in addition to the tunnel/pipeline features, there would be differences in the location, magnitude, duration, and frequency of construction activities and related water quality effects. In particular, relative to the existing conditions and No Action Alternative conditions, construction of the major canal features for CM1 under Alternative 1C LLT would involve extensive general construction activities, material handling/storage/placement activities, surface soil grading/excavation/disposal and associated exposure of disturbed sites to erosion and runoff, and construction site dewatering operations. Nevertheless, the construction of CM1 with the environmental commitments and agency permitted construction requirements and BMPs would result in the potential water quality effects being largely avoided and minimized. The specific environmental commitments that would be implemented under Alternative 1C would be similar to those described for Alternative 1A (refer to Chapter 3, *Description of AlternativesI,* for additional information regarding the environmental commitments and environmental permits). However, this alternative would involve environmental commitments associated with both tunnel/pipeline and canal construction activities. Consequently, relative to existing conditions, Alternative 1C LLT would not be expected to cause exceedance of applicable water quality objectives/criteria or substantial water quality degradation with respect to constituents of concern, and thus would not adversely affect any beneficial uses upstream of the Delta, in the Delta, or in the SWP and CVP service area.

8.3.4.5 Alternative 2A—Dual Conveyance with Tunnel and Five Intakes (15,000 cfs; Operational Scenario B)

Alternative 2A would convey up to 15,000 cfs of water from the north Delta to the south Delta through pipelines/tunnels from five screened intakes on the east bank of the Sacramento River between Clarksburg and Walnut Grove. A new Byron Tract Forebay,adjacent to and south of Clifton Court Forebay, would be constructed which would provide water to the south Delta pumping plants. Alternative 2A would include the same physical/structural components as Alternative 1A, but could potentially include two different intake and intake pumping plant locations. Water supply and conveyance operations would follow the guidelines described as Scenario B, which includes fall X2. CM2–CM22 would be implemented under this alternative, and would be the same as those under Alternative 1A. See Chapter 3, *Description of Alternatives*, for additional details on Alternative 2A.

Impact WQ-1: Effects on ammonia concentrations resulting from facilities operations and maintenance (CM1)

Upstream of the Delta

For the same reasons stated for the No Action Alternative LLT, Alternative 2A LLT would have negligible, if any, effect on ammonia concentrations in the rivers and reservoirs upstream of the Delta relative to existing conditions and the No Action Alternative NT and LLT. Any negligible increases in ammonia-N concentrations that could occur in the water bodies of the affected environment upstream of the Delta would not be of frequency, magnitude, and geographic extent that would adversely affect any beneficial uses or substantially degrade the quality of these water bodies, with regard to ammonia.

Delta

Assessment of the effects of ammonia under Alternative 2A LLT is the same as discussed under Alternative 1A, Impact WQ-1, except that because flows in the Sacramento River at Freeport would be different between the two alternatives, estimated monthly average and long term annual average predicted ammonia-N concentrations in the Sacramento River downstream of Freeport are different.

As Table 8-55 shows, estimated ammonia-N concentrations in the Sacramento River downstream of Freeport (upon full mixing of the SRWTP discharge with river water) under Alternative 2A LLT and the No Action Alternative LLT are expected to be similar. Minor increases in ammonia-N concentrations would occur during July through September, November through January, and April, and remaining months would be unchanged or have a minor decrease. Annual average concentrations would be the same under both Alternative 2A LLT and the No Action Alternative LLT. Moreover, the estimated concentrations downstream of Freeport under Alternative 2A LLT would be similar to existing source water concentrations for the San Francisco Bay and San Joaquin River. Consequently, changes in source water fraction anticipated under Alternative 2A LLT, relative to the No Action Alternative LLT, would not be expected to substantially increase ammonia concentrations at any Delta locations.

Any negligible increases in ammonia-N concentrations that could occur at certain locations in the Delta would not be of frequency, magnitude, and geographic extent that would adversely affect any beneficial uses or substantially degrade the water quality at these locations, with regards to ammonia.

Table 8-55. Estimated Ammonia-N (mg-L as N) Concentrations in the Sacramento River Downstream of the Sacramento Regional Wastewaster Treatment Plant for the No Action Alternative LLT and Alternative 2A LLT

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual Average
No Action Alternative LLT	0.081	0.073	0.061	0.055	0.053	0.055	0.061	0.070	0.072	0.064	0.072	0.069	0.063
Alternative 2A LLT	0.080	0.076	0.062	0.056	0.053	0.055	0.062	0.067	0.067	0.068	0.078	0.071	0.063

SWP/CVP Export Service Areas

The assessment of effects on ammonia in the SWP/CVP Export Service Area is based on assessment of ammonia-N concentrations at Banks and Jones pumping plants. Similar to the discussion for Alternative 1A, under Alternative 2A for areas of the Delta that are influenced by Sacramento River water, including Banks and Jones pumping plants, ammonia-N concentrations would be expected to decrease, relative to existing conditions and No Action Alternative NT. This decrease in ammonia-N concentrations for water exported via the south Delta pumps would not be expected to result in an adverse effect on beneficial uses or substantially degrade water quality of exported water, with regards to ammonia.

Furthermore, as discussed above for the PlanArea, for all areas of the Delta, including Banks and Jones pumping plants, ammonia-N concentrations would not be expected to substantially differ under Alternative 2A LLT, relative to the No Action Alternative LLT. Any negligible increases in ammonia-N concentrations that could occur at Banks and Jones pumping plants would not be of frequency, magnitude, and geographic extent that would adversely affect any beneficial uses or substantially degrade the water quality at these locations, with regards to ammonia.

***CEQA Conclusion*:** There would be no substantial, long-term increase in ammonia-N concentrations in the rivers and reservoirs upstream of the Delta, in the PlanArea, or the waters exported to the CVP and SWP service areas under Alternative 2A LLT relative to existing conditions. As such, this alternative would not be expected to cause additional exceedance of applicable water quality objectives/criteria by frequency, magnitude, and geographic extent that would cause significant impacts on any beneficial uses of waters in the affected environment. Because ammonia concentrations would not be expected to increase substantially, no long-term water quality degradation would be expected to occur and, thus, no significant impact on beneficial uses would occur. Ammonia is not 303(d) listed within the affected environment and thus any minor increases that could occur in some areas would not make any existing ammonia-related impairment measurably worse because no such impairments currently exist. Because ammonia-N is not bioaccumulative, minor increases that could occur in some areas would not bioaccumulate to greater levels in aquatic organisms that would, in turn, pose substantial health risks to fish, wildlife, or humans. This impact would be considered less than significant. No mitigation is required.

Impact WQ-2: Effects on ammonia concentrations resulting from implementation of CM2–CM22

Effects of CM2–23 on ammonia under Alternative 2A LLT are the same as those discussed for Alternative 1A LLT. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-3: Effects on boron concentrations resulting from facilities operations and maintenance (CM1)

Upstream of the Delta

Effects of CM1 on boron under Alternative 2A LLT in areas upstream of the Delta would be very similar to the effects discussed for Alternative 1A LLT. There would be no expected change to the sources of boron in the Sacramento and east-side tributary watersheds, and resultant changes in flows from altered system-wide operations would have negligible, if any, effects on the concentration of boron in the rivers and reservoirs of these watersheds. The modeled long-term annual average lower San Joaquin River flow at Vernalis would decrease slightly compared to existing conditions and the No Action Alternative NT, and would be similar compared to the No Action Alternative LLT. The reduced flow would result in possible increases in long-term average boron concentrations of up to about 3% relative to the existing conditions and No Action Alternative NT conditions. The increased boron concentrations would not increase the frequency of exceedances of any applicable objectives or criteria and would not be expected to cause further degradation at measurable levels in the lower San Joaquin River, and thus would not cause the existing impairment there to be discernibly worse. Consequently, Alternative 2A LLT would not be expected to cause exceedance of boron objectives/criteria or substantially degrade water quality with respect to boron, and thus would not adversely affect any beneficial uses of the Sacramento River, the east-side tributaries, associated reservoirs upstream of the Delta, or the San Joaquin River.

Delta

Effects of CM1 on boron under Alternative 2A LLT in the Delta would be very similar to the effects discussed for Alternative 1A LLT. Relative to the existing conditions, No Action Alternative NT, and No Action Alternative LLT, Alternative 2A LLT would result in similar or reduced long-term average boron concentrations for the 16-year period modeled at northern and eastern Delta locations, and would increase at interior and western Delta locations (by as much as 9% at the SF Mokelumne River at Staten Island, 19% at Franks Tract, 19% at Old River at Rock Slough, and 5% at the Sacramento River at Emmaton) (Appendix 8F, Table Bo-8). Implementation of tidal habitat restoration under conservation measure CM4 also may contribute to increased boron concentrations at western Delta assessment locations, and thus would not be anticipated to substantially affect agricultural diversions which occur primarily at interior Delta locations. The long-term annual average and monthly average boron concentrations, for either the 16-year period or drought period modeled, would never exceed the 2,000 µg/L human health advisory objective (i.e., for children) or 500 µg/L agricultural objective at any of the eleven Delta assessment locations, which represents no change from the existing conditions and No Action Alternative NT and LLT conditions (Appendix 8F, Table Bo-3). Reductions in long-term average assimilative capacity of up to 10% at interior Delta locations (i.e., Franks Tract and Old River at Rock Slough) would be small with respect to the 500 µg/L agricultural objective (Appendix 8F, Table Bo-9). However, because the absolute boron concentrations would still be well below the lowest 500 µg/L objective for the protection of the agricultural beneficial use under Alternative 2A LLT, the levels of boron degradation would not be of sufficient magnitude to substantially increase the risk of exceeding objectives or cause adverse effects to municipal and agricultural water supply beneficial uses, or any other beneficial uses, in the Delta (Appendix 8F, Figure Bo-2).

SWP/CVP Export Service Areas

Effects of CM1 on boron under Alternative 2A LLT in the Delta would be very similar to the effects discussed for Alternative 1A LLT. Under Alternative 2A LLT, long-term average boron concentrations would decrease by as much as 25% at the Banks Pumping Plant and by as much 27% at Jones Pumping Plant relative to existing conditions, No Action Alternative NT, and No Action Alternative LLT (Appendix 8F, Table Bo-8). Commensurate with the decrease in exported boron concentrations, boron concentrations in the lower San Joaquin River may be reduced and would likely alleviate or lessen any expected increase in boron concentrations at Vernalis associated with flow reductions (see discussion of Upstream of the Delta), as well locations in the Delta receiving a large fraction of San Joaquin River water. Reduced export boron concentrations also may contribute to reducing the existing 303(d) impairment in the lower San Joaquin River and associated TMDL actions for reducing boron loading.

Maintenance of SWP and CVP facilities under Alternative 2A LLT would not be expected to create new sources of boron or contribute towards a substantial change in existing sources of boron in the affected environment. Maintenance activities would not be expected to cause any substantial increases in boron concentrations or degradation with respect to boron such that objectives would be exceeded more frequently, or any beneficial uses would be adversely affected anywhere in the affected environment.

CEQA Conclusion: Boron is not a bioaccumulative constituent, thus any increased concentrations under Alternative 2A LLT would not result in adverse boron bioaccumulation effects to aquatic life or humans. Relative to existing conditions, Alternative 2A LLT would not result in any substantial increases in boron concentration upstream of the Delta. Alternative 2A LLT maintenance also would not result in any substantial increases in boron concentrations in the affected environment. Relative to existing conditions, Alternative 2A LLT would not result in substantially increased boron concentrations such that frequency of exceedances of municipal and agricultural water supply objectives would increase. The levels of boron degradation that may occur under Alternative 2A LLT would not be of sufficient magnitude to cause substantially increased risk for adverse effects to municipal or agricultural beneficial uses within the affected environment. Long-term average boron concentrations would decrease in Delta water exports to the SWP and CVP service area, which may contribute to reducing the existing 303(d) impairment of agricultural beneficial uses in the lower San Joaquin River. Based on these findings, this impact is determined to be less than significant. No mitigation is required.

Impact WQ-4: Effects on boron concentrations resulting from implementation of CM2–CM22

Effects of CM2--CM22 on boron under Alternative 2A LLT are the same as those discussed for Alternative 1A LLT. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-5: Effects on bromide concentrations resulting from facilities operations and maintenance (CM1)

Upstream of the Delta

Under Alternative 2A LLT there would be no expected change to the sources of bromide in the Sacramento and eastside tributary watersheds. Bromide loading in these watersheds would remain unchanged and resultant changes in flows form altered system-wide operations under Alternative 2A LLT would have negligible, if any, effects on the concentration of bromide in the rivers and reservoirs of these watersheds. Consequently, Alternative 2A LLT would not be expected to adversely affect the MUN beneficial use, or any other beneficial uses, of the Sacramento River, the eastside tributaries, or their associated reservoirs upstream of the Delta.

Under Alternative 2A LLT, modeling indicates that long-term annual average flows on the San Joaquin River would decrease by 6%, relative to existing conditions, 5% relative to No Action Alternative NT, and would remain virtually the same relative to No Action Alternative LLT. Similar to the No Action Alternative LLT, these decreases in flow would result in possible increase in long-term average bromide concentrations of about 3%, relative to existing conditions, 2% relative to No Action Alternative NT, and less than <1% relative to No Action Alternative LLT. The small increases in lower San Joaquin River bromide levels that could occur under Alternative 2A LLT, relative to existing, No Action Alternative NT, and No Action Alternative LLT conditions would not be expected to adversely affect the MUN beneficial use, or any other beneficial uses, of the lower San Joaquin River.

Delta

Under Alternative 2A LLT, the geographic extent of effects pertaining to long-term average bromide concentrations in the Delta would be similar to that previously described for Alternative 1A LLT, although the magnitude of predicted long-term change and relative frequency of concentration threshold exceedances would be different. Relative to existing conditions, modeled long-term average bromide concentrations would increase at Staten Island, Emmaton (during the drought period only), and Barker Slough, while modeled long-term average bromide concentrations would decrease at all other assessment locations(Appendix 8E, Bromide Table 6-7). Overall effects would be greatest at Barker Slough, where predicted long-term average bromide concentrations would increase from 51 µg/L to 63 µg/L (22% relative increase) for the modeled 16-year hydrologic period and would increase from 54 µg/L to 94 µg/L (75% relative increase) for the modeled drought period. At Barker Slough, the predicted 50 µg/L exceedance frequency would decrease from 49% under existing conditions to 38% under Alternative 2A LLT, but would increase from 55% to 63% during the drought period. At Barker Slough, the predicted 100 µg/L exceedance frequency would increase from 0% under existing conditions to 17% under Alternative 2A LLT, and would increase from 0% to 38% during the drought period. Relative increases in long-term average bromide concentrations at Staten Island would be of similar magnitude to that described for Barker Slough, although modeled 100 µg/L exceedance frequency increases would be much less considerable. At Staten Island, the predicted 100 µg/L exceedance frequency would increase from 1% under existing conditions to 4% under Alternative 2A LLT (0% to 2% during the drought period). Modeled long-term average concentration at Staten Island would be about 62 µg/L (about 63 µg/L in drought years). Changes in exceedance frequency of the 50 µg/L and 100 µg/L concentration thresholds, as well as relative change in long-term average concentration, at other assessment locations would be less substantial.

Due to the relatively small differences between modeled existing conditions and No Action baselines, changes in long-term average bromide concentrations and changes in exceedance frequencies relative to No Action Alternative NT and No Action Alternative LLT are generally of similar magnitude to those previously described for the existing condition comparison (Appendix 8E, Bromide Table 6-7). Modeled long-term average bromide concentration increases would similarly be greatest at Barker Slough, where long-term average concentrations are predicted to increase by about 28% (about 79% in drought years) relative to No Action Alternative NT, and would increase by about 26% (about 75% in drought years) relative to No Action Alternative LLT. However, unlike the existing conditions comparison, long-term average bromide concentrations at Buckley Cove under Alternative 2A LLT would increase relative to No Action Alternative NT and No Action Alternative LLT, although the increases would be relatively small (≤4%).

The increase in long-term average bromide concentrations predicted at Barker Slough, principally the relative increase in 100 µg/L exceedance frequency, would result in a substantial change in source water quality for existing drinking water treatment plants drawing water from the North Bay Aqueduct. As discussed for Alternative 1A, drinking water treatment plants obtaining water via the North Bay Aqueduct utilize a variety of conventional and enhanced treatment technologies in order to achieve DBP drinking water criteria. While the implications of such a modeled change in bromide at Barker Slough are difficult to predict, the substantial modeled increases could lead to adverse changes in the formation of disinfection byproducts such that considerable treatment plant upgrades may be necessary in order to achieve equivalent levels of health protection.

The seasonal intakes at Mallard Slough and City of Antioch are infrequently used due to water quality constraints related to sea water intrusion. On a long-term average basis, bromide at these locations is in excess of 3,000 µg/L, but during seasonal periods of high Delta outflow can be <300 µg/L. Use of the seasonal intakes at Mallard Slough and City of Antioch under Alternative 2A LLT would experience a period average increase in bromide during the months when these intakes would most likely be utilized. For those wet and above normal water year types where mass balance modeling would predict water quality typically suitable for diversion, predicted long-term average bromide would increase from 103 µg/L to 165 µg/L (61% increase) at City of Antioch and would increase from 150 µg/L to 211 µg/L (41% increase) at Mallard Slough relative to existing conditions (Appendix 8E, Bromide Figure 2-3). Increases would be similar for No Action Alternative NT and No Action Alternative LLT comparison. The decisions surrounding the use of these seasonal intakes is largely driven by acceptable water quality, and thus have historically been opportunistic. Opportunity to use these intakes would remain, and the predicted increases in bromide concentrations at the City of Antioch and Mallard Slough intake would not be expected to adversely affect MUN beneficial uses, or any other beneficial use, at these locations.

SWP/CVP Export Service Areas

Under Alternative 2A LLT, improvement in long-term average bromide concentrations would occur at the Banks and Jones pumping plants. Long-term average bromide concentrations for the modeled 16-year hydrologic period at these locations would decrease by as much as 46% relative to existing conditions, 42% relative to No Action Alternative NT, and 39% relative to No Action Alternative LLT. Relative change in long-term average bromide concentration would be less during drought conditions (≤34%), but would still represent considerable improvement (Appendix 8E, Bromide Tables 6-7). As a result, less frequent bromide concentration exceedances of the 50 µg/L and 100 µg/L assessment thresholds would be predicted and an overall improvement in Export Service Areas water quality would be experienced respective to bromide. Commensurate with the decrease in exported bromide, an improvement in lower San Joaquin River bromide would also be observed since bromide in the lower San Joaquin River is principally related to irrigation water deliveries from the Delta. While the magnitude of this expected lower San Joaquin River improvement in bromide is difficult to predict, the relative decrease in overall loading of bromide to the Export Service Areas would likely alleviate or lessen any expected increase in bromide concentrations at Vernalis (see discussion of Upstream of the Delta) as well locations in the Delta receiving a large fraction of San Joaquin River water, such as much of the south Delta.

Similar to the discussion pertaining to the No Action Alternative LLT, maintenance of SWP and CVP facilities under Alternative 2A LLT would not be expected to create new sources of bromide or contribute towards a substantial change in existing sources of bromide in the affected environment. Maintenance activities would not be expected to cause any substantial change in bromide such that MUN beneficial uses, or any other beneficial use, would be adversely affected anywhere in the affected environment.

***CEQA Conclusion*:** Relative to existing conditions, Alternative 2A LLT operation and maintenance would not result in any substantial change in long-term average bromide concentration upstream of the Delta. Furthermore, under Alternative 2A LLT, water exported from the Delta to the SWP/CVP service area would be substantially improved relative to bromide. Bromide is not bioaccumulative, therefore change in long-term average bromide concentrations would not directly cause bioaccumulative problems in aquatic life or humans. Additionally, bromide is not a constituent related to any 303(d) listings. Alternative 2A LLT operation and maintenance activities would not cause substantial long-term degradation to water quality respective to bromide with the exception of water quality at Barker Slough, source of the North Bay Aqueduct. At Barker Slough, modeled long-term annual average concentrations of bromide would increase by 22%, and 75% during the modeled drought period. For the modeled 16-year hydrologic period the frequency of predicted bromide concentrations exceeding 100 µg/L would increase from 0% under existing conditions to 17% under Alternative 2A LLT, while for the modeled drought period, the frequency would increase from 0% to 38%. Substantial changes in long-term average bromide could necessitate changes in treatment plant operation or require treatment plant upgrades in order to maintain DBP compliance. The model predicted change at Barker Slough is substantial and, therefore, would represent a substantially increased risk for adverse effects on existing MUN beneficial uses should treatment upgrades not be undertaken. The impact is considered significant and mitigation is required. Implementation of Mitigation Measure WQ-5would reduce identified impacts to a less than significant level by relocating the North Bay Aqueduct outside the influence of sea water intrusion.

Mitigation Measure WQ-5: Move the North Bay Aqueduct intake from Barker Slough to the Sacramento River

Please see Mitigation Measure WQ-5 under Impact WQ-5 in the discussion of Alternative 1A.

Impact WQ-6: Effects on bromide concentrations resulting from implementation of CM2–CM22

Conservation components proposed under Alternative 2A LLT would be the same as those proposed under Alternative 1A LLT. As discussed for Alternative 1A LLT, implementation of CM2–CM22 would not present new or substantially changed sources of bromide to the project area. Some conservation measures may replace or substitute for existing irrigated agriculture in the Delta. This replacement or substitution is not expected to substantially increase or present new sources of bromide. CM2–CM22 would not be expected to cause any substantial change in bromide such that MUN beneficial uses, or any other beneficial use, would be adversely affected anywhere in the affected environment.

CEQA Conclusion: Conservation components proposed under Alternative 2A LLT would be similar to those proposed under Alternative 1A LLT. As such, effects on bromide resulting from the implementation of CM2–CM22 would be similar to that previously discussed for Alternative 1A LLT. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-7: Effects on chloride concentrations resulting from facilities operations and maintenance (CM1)

Upstream of the Delta

Under Alternative 2A LLT there would be no expected change to the sources of chloride in the Sacramento and eastside tributary watersheds. Chloride loading in these watersheds would remain unchanged and resultant changes in flows from altered system-wide operations would have negligible, if any, effects on the concentration of chloride in the rivers and reservoirs of these watersheds. The modeled long-term annual average flows on the lower San Joaquin River at Vernalis would decrease slightly compared to existing conditions and the No Action Alternative NT, and be similar compared to the No Action Alternative LLT. The reduced flow would result in possible increases in long-term average chloride concentrations of up to about 3%, relative to the existing conditions and No Action Alternative NT conditions, and no change relative to No Action Alternative LLT. The increased chloride concentrations would not increase the frequency of exceedances of any applicable objectives or criteria. Consequently, Alternative 2A LLT would not be expected to cause exceedance of chloride objectives/criteria or substantially degrade water quality with respect to chloride, and thus would not adversely affect any beneficial uses of the Sacramento River, the eastside tributaries, associated reservoirs upstream of the Delta, or the San Joaquin River.

Delta

Relative to existing conditions, Alternative 2A LLT would result in similar or reduced long-term average chloride concentrations for the 16-year period modeled at nine of the assessment locations, and increased concentrations at the North Bay Aqueduct at Barker Slough (up 23%) and San Joaquin River at Staten Island (up 18%) (Appendix 8G, Chloride Table Cl-9). Additionally, implementation of tidal habitat restoration under conservation measure CM4 would increase the tidal exchange volume in the Delta, and thus may contribute to increased chloride concentrations in the Bay source water as a result of increased salinity intrusion. Consequently, while uncertain, the magnitude of chloride increases may be greater than indicated herein and would affect the western Delta assessment locations the most which are influenced to the greatest extent by the Bay source water. The following outlines the modeled chloride changes relative to the applicable objectives and beneficial uses of Delta waters.

Municipal Beneficial Uses

Relative to the 150 mg/L Bay-Delta WQCP objective for municipal and industrial beneficial uses, the plots of monthly average chloride concentrations at the Contra Costa Canal at Pumping Plant #1 for the separate water year types indicates that the number of months above the objective would remain unchanged or decrease compared to the existing conditions (Appendix 8G, Figure Cl-1). The modeled chloride concentrations at the San Joaquin River at Antioch location would never meet this objective; however, this represents no change from the existing conditions.

With respect to the 250 mg/L Bay-Delta WQCP objective, the modeled frequency of exceedances based on monthly average chloride concentrations would decrease at the Contra Costa Canal at Pumping Plant #1 (Appendix 8G, Table Cl-10). The frequency of exceedances would increase for the 16-year period modeled at the San Joaquin River at Antioch (i.e., from 66% under existing conditions to 70%) and Sacramento River at Mallard Island (i.e., from 85% under existing conditions to 88%) (Appendix 8G, Table Cl-10), and would cause further degradation at Antioch in March and April (i.e., maximum reduction of 54% of available assimilative capacity for the 16-year period modeled, and 100% reduction, or elimination of assimilative capacity, during the drought period modeled) (Appendix 8G, Table Cl-11). Based on the additional seasonal exceedances of the municipal objective and magnitude of long-term average water quality degradation with respect to chloride in the western Delta, the potential exists for substantial adverse effects on the municipal and industrial beneficial uses through reduced opportunity for diversion of water with acceptable salinity.

Aquatic Life Beneficial Uses

Relative to the 230 mg/L chronic EPA aquatic life criterion, monthly average chloride concentrations at the northern and eastern Delta locations would not exceed the criteria and the frequency of exceedances at most interior and southern Delta locations would decrease for the 16-year period modeled (Appendix 8G, Table Cl-10). Reductions in the modeled assimilative capacity at interior Delta locations (i.e., Franks Tract and Old River at Rock Slough) would occur during the January through June period when concentrations would be well below the criterion, and thus, would not adversely affect aquatic organisms (Appendix 8G, Table Cl-12).

303(d) Listed Water Bodies

With respect to the 303(d) listing for chloride in Tom Paine Slough, the monthly average chloride concentrations for the 16-year period modeled at Old River at Tracy Road would generally be similar compared to existing conditions, and thus, would not be further degraded on a long-term basis (Appendix 8G, Figure Cl-3). With respect to Suisun Marsh, the monthly average chloride concentrations for the 16-year period modeled would generally increase compared to existing conditions in some months during October through May at the Sacramento River at Collinsville (Appendix 8G, Figure Cl-4) and Mallard Island (Appendix 8G, Figure Cl-2), and would increase substantially at Montezuma Slough at Beldon's Landing (i.e., over a doubling of concentration in December through February) (Appendix 8G, Figure Cl-5), thereby contributing to additional, measureable long-term degradation that potentially would adversely affect the necessary actions to reduce chloride loading for any TMDL that is developed.

Relative to the No Action Alternative NT and No Action Alternative LLT conditions, Alternative 2A LLT would result in similar or reduced long-term average chloride concentrations for the 16-year period modeled at nine of the assessment locations and increased concentrations at the SF Mokelumne River at Staten Island (up to 23%), San Joaquin River at Buckley Cove (up to 2%), and the North Bay Aqueduct at Barker Slough (up to 23%) compared to the No Action Alternative NT conditions (Appendix 8G, Table Cl-9). The modeled chloride changes relative to the applicable objectives and potential effects on beneficial uses are as follows.

SWP/CVP Export Service Areas

Under Alternative 2A LLT, long-term average chloride concentrations for the 16-year period modeled at the Banks and Jones pumping plants would decrease by as much as 33% relative to existing conditions, 31% relative to No Action Alternative NT, and 28% compared to No Action Alternative LLT. The modeled frequency of exceedances of applicable water quality objectives/criteria would decrease relative to existing conditions, No Action Alternative NT, and No Action Alternative LLT, for both the 16-year period and the drought period modeled (Appendix 8G, Chloride Table Cl-6). Consequently, water exported into the SWP/CVP service area would generally be of similar or better quality with regards to chloride relative to existing conditions and the No Action Alternative NT and No Action Alternative LLT conditions.

Commensurate with the reduced chloride concentrations in water exported to the service area, reduced chloride loading in the lower San Joaquin River would be anticipated which would likely alleviate or lessen any expected increase in chloride at Vernalis related to decreased annual average San Joaquin River flows (see discussion of Upstream of the Delta).

Maintenance of SWP and CVP facilities would not be expected to create new sources of chloride or contribute towards a substantial change in existing sources of chloride in the affected environment. Maintenance activities would not be expected to cause any substantial change in chloride such that any long-term water quality degradation would occur, thus, beneficial uses would not be adversely affected anywhere in the affected environment.

CEQA Conclusion: Chloride is not a bioaccumulative constituent, thus any increased concentrations under Alternative 2A LLT would not result in adverse chloride bioaccumulation effects on aquatic life or humans. Alternative 2A LLT maintenance would not result in any substantial changes in chloride concentration upstream of the Delta or in the SWP/CVP service area. Relative to existing conditions, the Alternative 2A LLT would result in substantially increased chloride concentrations such that frequency of exceedances of the 250 mg/L Bay-Delta WQCP objective would increase at the San Joaquin River at Antioch and at Mallard Slough (by 3% each), and long-term degradation may occur, that may result in adverse effects on the municipal and industrial water supply beneficial use. Relative to the existing conditions, the modeled increased chloride concentrations and degradation in the western Delta could further contribute, at measurable levels (i.e., over a doubling of concentration), to the existing 303(d) listed impairment due to chloride in Suisun Marsh for the protection of fish and wildlife. Based on these findings, this impact is determined to be potentially significant due to increased chloride concentrations and degradation at western Delta locations and its effects on municipal and industrial water supply and fish and wildlife beneficial uses.

While implementation of Mitigation Measure WQ-7 may reduce this impact, the feasibility and effectiveness of this mitigation measures is uncertain. Therefore, the available mitigation would not necessarily reduce the impact to a level that would be less than significant.

Mitigation Measure WQ-7: Conduct additional evaluation and modeling of increased chloride levels and develop and implement phased actions to reduce levels

Please see Mitigation Measure WQ-7 under Impact WQ-7 in the discussion of Alternative 1A.

Impact WQ-8: Effects on chloride concentrations resulting from implementation of CM2–CM22

Under Alternative 2A LLT, the types and geographic extent of effects on chloride concentrations in the Delta as a result of implementation of the other conservation measures (i.e., CM2–CM22) would be similar to, and undistinguishable from, those effects previously described for Alternative 1A LLT. The conservation measures would present no new direct sources of chloride to the affected environment. Moreover, some habitat restoration conservation measures (CM4–CM10) would occur on lands within the Delta currently used for irrigated agriculture, thus replacing agricultural land uses with restored tidal wetlands, floodplain, and related channel margin and off-channel habitats. The potential reduction in irrigated lands within the Delta may result in reduced discharges of agricultural field drainage with elevated chloride concentrations, which would be considered an improvement compared to existing conditions.

CEQA Conclusion: Implementation of the CM2–CM22 for Alternative 2A LLT would not present new or substantially changed sources of chloride to the affected environment upstream of the Delta, within Delta, or in the SWP/CVP service area. Replacement of irrigated agricultural land uses in the Delta with habitat restoration conservation measures may result in some reduction in discharge of agricultural field drainage with elevated chloride concentrations, thus resulting in improved water quality conditions. Based on these findings, this impact is considered to be less than significant. No mitigation is required.

Impact WQ-9: Effects on dissolved oxygen resulting from facilities operations and maintenance (CM1)

Effects of CM1 on DO under Alternative 2A LLT are the same as those discussed for Alternative 1A LLT. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-10: Effects on dissolved oxygen resulting from implementation of CM2–CM22

Effects of CM2–CM22 on DO under Alternative 2A LLT are the same as those discussed for Alternative 1A LLT. There would not be an adverse effect. Under CEQA, this impact would be considered less than significant. No mitigation is required.

Impact WQ-11: Effects on electrical conductivity concentrations resulting from facilities operations and maintenance (CM1)

Upstream of the Delta

For the same reasons stated for the No Action Alternative LLT, EC levels (highs, lows, typical conditions) in the Sacramento River and its tributaries, the eastside tributaries, their associated reservoirs, and the San Joaquin River upstream of the Delta under Alternative 2A LLT are not expected to be outside the ranges occurring under existing conditions or would occur under the No Action Alternative NT and LLT. Any minor changes in EC levels that could occur under Alternative 2A LLT in water bodies upstream of the Delta would not be of sufficient magnitude, frequency and geographic extent that would cause adverse effects on beneficial uses or substantially degrade water quality with regard to EC.

Delta

Relative to existing conditions, Alternative 2A LLT would result in an increase in the number of days the Bay-Delta WQCP EC objectives would be exceeded in the San Joaquin River at San Andreas Landing and Prisoners Point, and Old River near Middle River andat Tracy Bridge (Appendix H, Table EC-2). The percent of days the San Andreas Landing EC objective would be exceeded for the entire period modeled (1976-1991) would increase from 1% under existing conditions to 4% under Alternative 2A LLT, and the percent of days out of compliance with the EC objective would increase from 1% under existing conditions to 6% under Alternative 2A LLT. The percent of days the Prisoners Point EC objective would be exceeded for the entire period modeled would increase from 6% under existing conditions to 25% under Alternative 2A LLT, and the percent of days out of compliance with the EC objective would increase from 10% under existing conditions to 27% under Alternative 2A LLT. The increase in percent of days exceeding the EC objectives and days out of compliance at the Old River locations would be 2% at Tracy Bridge and less than 1% at Middle River. Average EC levels at the western and southern Delta compliance locations would decrease from 0-37% for the entire period modeled and 0-32% during the drought period modeled (1987-1991) (Appendix H, Table EC-13). At the two interior Delta locations, there would be increases in average EC: the S. Fork Mokelumne River at Terminous average EC would increase 5% for the entire period modeled and 4% during the drought period modeled; and San Joaquin River at San Andreas Landing average EC would increase 1% for the entire period modeled and 10% during the drought period modeled. On average, EC would increase at San Andreas Landing from February through September. Average EC in the S. Fork Mokelumne River at Terminous would increase during all months (Appendix H, Table EC-13).

Relative to the No Action Alternative NT, the change in percent compliance with Bay-Delta WQCP EC objectives under Alternative 2A LLT would be similar to that described above relative to existing conditions. The exception is that there would also be a slight increase (1% or less) in the percent of days the EC objective would be exceeded in the San Joaquin River at Vernalis and Brandt Bridge for the entire period modeled. For the entire period modeled, average EC levels would increase at all Delta compliance locations relative to the No Action Alternative NT, except in Three Mile Slough near the Sacramento River and the San Joaquin River at Jersey Point. The greatest average EC increase would occur in the San Joaquin River at San Andreas Landing (11%); the increase at the other locations would be 3-5% (Appendix H, Table EC-13). Similarly, during the drought period modeled, average EC would increase at all locations, except Three Mile Slough and San Joaquin River at Jersey Point. The greatest average EC increase during the drought period modeled would occur in the San Joaquin River at San Andreas Landing (18%); the increase at the other locations would be 1-8% (Appendix H, Table EC-13).

Relative to the No Action Alternative LLT, the locations with an increased frequency of exceedance of the Bay-Delta WQCP EC objectives under Alternative 2A LLT would differ from that described relative to the No Action Alternative NT (Appendix H, Table EC-2). The percent of days exceeding EC objectives and percent of days out of compliance would increase at: San Joaquin River at Jersey Point, San Andreas Landing, and Prisoners Point; and Old River near Middle River and at Tracy Bridge. The increase in percent of days exceeding the EC objective would be 24% at Prisoners Point and 4% or less at the remaining locations. The increase in percent of days out of compliance would be 26% at Prisoners Point and 5% or less at the remaining locations. Average EC would increase similar to that described above relative to the No Action Alternative NT.

For Suisun Marsh, October-May is the period when Bay-Delta WQCP EC objectives for protection of fish and wildlife apply. Average EC would increase for the entire period modeled under Alternative 2A LLT, relative to existing conditions, during the months of March through May by 0.3-0.6 mS/cm in the Sacramento River at Collinsville (Appendix H, Table EC-21). Long-term average EC would decrease relative to existing conditions in Montezuma Slough at National Steel during October-May (Appendix H, Table EC-22). The most substantial increase would occur near Beldon Landing, with long-term average EC levels increasing by 1.6-4.6 mS/cm, depending on the month, at least doubling during some months the long-term average EC relative to existing conditions (Appendix H, Table EC-23). Sunrise Duck Club and Volanti Slough also would have long-term average EC increases during all months of 0.5-2.4 mS/cm (Appendix H, Tables EC-24 and EC-25). The degree to which the long-term average EC increases would cause exceedance of Bay-Delta WQCP objectives is unknown, because objectives are expressed as a monthly average of daily high tide EC, which does not have to be met if it can be demonstrated "equivalent or better protection will be provided at the location" (State Water Resources Control Board 2006:14). The described long-term average EC increase may, or may not, contribute to adverse effects on beneficial uses, depending on how and when wetlands are flooded, soil leaching cycles, and how recirculation of water is managed, and future actions taken with respect to the marsh. However, the EC increases at certain locations would be substantial and it is uncertain the degree to which current management plans for the Suisun Marsh would be able to address these substantially higher EC levels and protect beneficial uses. Thus, these increased EC levels in Suisun Marsh are considered to have a potentially adverse effect on marsh beneficial uses. Long-term average EC increases in Suisun Marsh under Alternative 2A LLT relative to the No Action Alternative NT and LLT would be similar to the increases relative to existing conditions.

Given that the southern Delta is Clean Water Act section 303(d) listed as impaired due to elevated EC, the increase in the incidence of exceedance of EC objectives under Alternative 2A LLT, relative to existing conditions and the No Action Alternative NT and LLT, has the potential to contribute to additional impairment and potentially adversely affect beneficial uses. Suisun Marsh also is section 303(d) listed as impaired due to elevated EC, and the potential increases in long-term average EC concentrations could contribute to additional impairment, because the increases would be double that relative to existing conditions and the No Action Alternative NT and LLT.

SWP/CVP Export Service Areas

At the Banks and Jones pumping plants, Alternative 2A LLT would result in no exceedances of the Bay-Delta WQCP's 1,000 µmhos/cm EC objective for the entire period modeled (Appendix H, Table EC-10). Thus, there would be no adverse effect to the beneficial uses in the SWP/CVP Export Service Areas using water pumped at this location under the Alternative 2A LLT.

At the Banks pumping plant, relative to existing conditions, average EC levels under Alternative 2A LLT would decrease 28% for the entire period modeled and 22% during the drought period modeled. Relative to the No Action Alternative NT, average EC levels would decrease by 22% for the entire period modeled and 16% during the drought period modeled. Similar decreases in average EC would occur relative to the No Action Alternative LLT. (Appendix H, Table EC-13)

At the Jones pumping plant, relative to existing conditions, average EC levels under Alternative 2A LLT would decrease 28% for the entire period modeled and 23% during the drought period modeled. Relative to the No Action Alternative NT, average EC levels would decrease by 22% for the entire period modeled and 18% during the drought period modeled. Similar decreases in average EC would occur relative to the No Action Alternative LLT. (Appendix H, Table EC-13)

Based on the decreases in long-term average EC levels that would occur at the Banks and Jones pumping plants, Alternative 2A LLT would not cause degradation of water quality with respect to EC in the SWP/CVP Export Service Areas; rather, Alternative 2A LLT would improve long-term average EC conditions in the SWP/CVP Export Service Areas.

Commensurate with the EC decrease in exported waters, an improvement in lower San Joaquin River average EC levels would be expected since EC in the lower San Joaquin River is, in part, related to irrigation water deliveries from the Delta. While the magnitude of this expected lower San Joaquin River improvement in EC is difficult to predict, the relative decrease in overall loading of EC-elevating constituents to the Export Service Areas would likely alleviate or lessen any expected increase in EC at Vernalis related to decreased annual average San Joaquin River flows (see EC impact discussion under No Action Alternative LLT).

The export area of the Delta is listed on the state's CWA Section 303(d) list as impaired due to elevated EC. Alternative 2A LLT would result in lower average EC levels relative to existing conditions and the No Action Alternative NT and LLT and, thus, would not contribute to additional beneficial use impairment related to elevated EC in the SWP/CVP Export Service Areas waters.

CEQA Conclusion: Relative to existing conditions, Alternative 2A LLT would not result in any substantial increases in long-term average EC levels upstream of the Delta or in the SWP/CVP Export Service Areas. In the Plan Area, Alternative 2A LLT would result in an increase in the frequency with which Bay-Delta WQCP EC objectives are exceeded for the entire period modeled (1976-1991): in the San Joaquin River at San Andreas Landing (agricultural objective; 3% increase) and Prisoners Point (fish and wildlife objective; 19% increase), both in the interior Delta; and in Old River near Middle River and at Tracy Bridge (agricultural objectives; up to 2% increase), both in the southern Delta. Average EC levels at San Andreas Landing would increase by 1% during for the entire period modeled and 10% during the drought period modeled. The increases in long-term and drought period average EC levels and increased frequency of exceedance of EC objectives that would occur in the San Joaquin River at San Andreas Landing would potentially contribute to adverse effects on the agricultural beneficial uses in the interior Delta. Further, the increased frequency of exceedance of the fish and wildlife objective at Prisoners Point could contribute to adverse effects on aquatic life. Because EC is not bioaccumulative, the increases in long-term average EC levels would not directly cause bioaccumulative problems in aquatic life or humans. The southern Delta is Clean Water Act section 303(d) listed for elevated EC and the increased frequency of exceedance of EC objectives that would occur in this portion of the Delta could make beneficial use impairment measurably worse. This impact is considered to be potentially significant.

Further, relative to existing conditions, Alternative 2A LLT would result in substantial increases in long-term average EC during the months of October through May in Suisun Marsh, such that EC levels would be double that relative to existing conditions. The increases in long-term average EC levels that would occur in Suisun Marsh could further degrade existing EC levels and thus contribute additionally to adverse effects on the fish and wildlife beneficial uses. Because EC is not bioaccumulative, the increases in long-term average EC levels would not directly cause bioaccumulative problems in fish and wildlife. Suisun Marsh is Clean Water Act section 303(d) listed for elevated EC and the increases in long-term average EC that would occur in the marsh could make beneficial use impairment measurably worse. This impact is considered to be potentially significant.

While Mitigation Measure WQ-11 may reduce these impacts, the feasibility and effectiveness of this mitigation measures is uncertain. Therefore, the available mitigation would not necessarily reduce the impact to a level that would be less than significant.

Mitigation Measure WQ-11: Reduce, avoid, and compensate for reduced water quality conditions

Please see Mitigation Measure WQ-11 under Impact WQ-11 in the discussion of Alternative 1A.

Impact WQ-12: Effects on electrical conductivity resulting from implementation of CM2–CM22

Effects of CM2–CM22 on EC under Alternative 2A LLT are the same as those discussed for Alternative 1A LLT. There would be no adverse effect. Under CEQA, this impact would be considered less than significant. No mitigation is required.

Impact WQ-13: Effects on mercury concentrations resulting from facilities operations and maintenance (CM1)

[*Note to Lead Agencies: This assessment is in preparation*].

Impact WQ-14: Effects on mercury concentrations resulting from implementation of CM2–CM22

[*Note to Lead Agencies: This assessment is in preparation*].

Impact WQ-15: Effects on nitrate concentrations resulting from facilities operations and maintenance (CM1)

Upstream of the Delta

For the same reasons stated for the No Action Alternative LLT, Alternative 2A LLT would have negligible, if any, impact on nitrate concentrations in the rivers and reservoirs upstream of the Delta in the Sacramento River watershed relative to existing conditions and the No Action Alternative NT and LLT.

Under Alternative 2A LLT, modeling indicates that long-term annual average flows on the San Joaquin River would decrease by an estimated 6%, relative to existing conditions, 5% relative to No Action NT, and would remain virtually the same relative to No Action LLT (crossreference to Modeling Data Appendix, CALSIM Flow Data for Vernalis). Given these relatively small decreases in flows and the weak correlation between nitrate and flows in the San Joaquin River (see Nitrate Appendix J Figure 2), it is expected that nitrate concentrations in the San Joaquin River will be minimally affected, if at all, by changes in flow rates under Alternative 2A LLT.

Any negligible changes in nitrate-N concentrations that may occur in the water bodies of the affected environment located upstream of the Delta would not be of frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the quality of these water bodies, with regards to nitrate.

Delta

Results of the mixing calculations indicate that under Alternative 2A LLT, relative to existing conditions, No Action NT, and No Action LLT, nitrate concentrations throughout the Delta are anticipated to remain low (<1.4 mg/L-N) relative to adopted objectives (Nitrate Appendix J Table 10 and 11). Although changes at specific Delta locations and for specific months may be substantial on a relative basis, the absolute concentration of nitrate in Delta waters would remain low (<1.4 mg/L-N) in relation to the drinking water MCL of 10 mg/L-N, as well as all other thresholds identified in Table XX. Long-term average nitrate concentrations are anticipated to remain below 1 mg/L-N at all 11 assessment locations except the San Joaquin River at Buckley Cove, where long-term average concentrations would be somewhat above 1 mg/L-N. Nevertheless, at this location, long-term average nitrate concentration would be somewhat reduced under Alternative 2A LLT, relative to existing conditions, similar to the No Action NT, and slightly increased relative to the No Action LLT. No additional exceedances of the MCL are anticipated at any location (Nitrate Appendix J Table 10). On a monthly average basis and on a long term annual average basis, for all modeled years and for the drought period (1987-1991) only, use of assimilative capacity available under existing conditions, No Action NT, and No Action LLT, relative to the drinking water MCL of 10 mg/L-N, was low or negligible (i.e., <5%) for all locations and months, except San Joaquin River at Buckley Cove in August, which showed a 6.4% use of the assimilative capacity that was available under the No Action LLT, for the drought period (1987-1991) (Nitrate Appendix J Table 12).

Nitrate concentrations will likely be higher than the modeling results indicate in certain locations, including: (1) in the Sacramento River between Freeport and Mallard Island and other areas in the Delta downstream of Freeport that are influenced by Sacramento River water, the increase becoming greater with increasing distance downstream, due to conversion of ammonia from the SRWTP discharge at Freeport (under existing conditions and No Action Alternative NT only, since upgrades to SRWTP that substantially reduce ammonia concentrations in the Sacramento River downstream of Freeport are assumed in the LLT; see the Ammonia section of this chapter for further discussion); (2) immediately downstream of wastewater treatment plants that practice nitrification, but not denitrification (e.g., City of Rio Vista Beach WWTF, Town of Discovery Bay WWTF, City of Stockton RWCF).

The effect of (1) (above) is expected to be small, on the order of 1 mg/L nitrate as N or less in the existing conditions and No Action Alternative NT. This is because the existing increase appears to be from approximately 0.1 mg/L-N to approximately 0.4-0.5 mg/L-N over this reach, due to approximately a 1:1 conversion of ammonia-N to nitrate-N (CVWQCB 2010:32). Because this nitrate is assumed not to be generated under Alternative 2A LLT, average concentrations would be expected to decrease under Alternative 2A LLT in this reach of the Sacramento River relative to existing conditions and the No Action Alternative NT. Regarding number (2) (above), for all such facilities in the Delta, the Regional Water Boards have issued NPDES permits that allow discharge of wastewater containing nitrate into the Delta, and under these permits, the State has determined that no beneficial uses are adversely affected by the discharge, and that the discharger's use of available assimilative capacity of the water body is acceptable. When dilution is necessary in order for the discharge to be in compliance with the Basin Plans (which incorporate the 10 mg/L-N MCL by reference), not all of the assimilative capacity of the receiving water is granted to the discharger. Thus, limited decreases in flows are not anticipated to result in systemic exceedances of the MCLs by these POTWs. Furthermore, NPDES permits are renewed on a 5-year basis, and thus, if under changes in flows, dilution was no longer sufficient to maintain nitrate below the MCL in the receiving water, the NPDES permit renewal process would address such cases.

Therefore, any increases in nitrate-N concentrations that may occur at certain locations within the Delta would not be of frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the water quality at these locations, with regards to nitrate.

SWP/CVP Export Service Areas

Assessment of effects of nitrate in the SWP and CVP Export Service Areas is based on effects on nitrate-N at the Banks and Jones pumping plants.

Results of the mixing calculations indicate that under Alternative 2A LLT, relative to existing conditions, No Action NT, and No Action LLT, nitrate concentrations at Banks and Jones pumping plants are anticipated to decrease on a long-term average annual basis (Nitrate Appendix J Table 10 and 11). During the late summer, particularly in the drought period assessed, concentrations are expected to increase substantially on a relative basis (i.e., >50%), but the absolute value of these changes (i.e., in mg/L-N) is small. Additionally, given the many factors that contribute to potential algal blooms in the SWP and CVP canals within the Export Service Area, and the lack of studies that have shown a direct relationship between nutrient concentrations in the canals and reservoirs and problematic algal blooms in these water bodies, there is no basis to conclude that these small (i.e., generally <0.3 mg/L-N), seasonal increases in nitrate concentrations would increase the potential for problem algal blooms in the SWP and CVP Export Service Area. No additional exceedances of the MCL are anticipated (Nitrate Appendix J Table 10). On a monthly average basis and on a long term annual average basis, for all modeled years and for the drought period (1987-1991) only, use of assimilative capacity available under existing conditions and No Action NT, relative to the 10 mg/L-N MCL, was negligible for both Banks and Jones pumping plants (Nitrate Appendix J Table 12).

Any increases in nitrate-N concentrations that may occur in water exported via Banks and Jones pumping plants are not expected to result in adverse effects to beneficial uses or substantially degrade the quality of exported water, with regards to nitrate.

***CEQA Conclusion*:** There would be no substantial, long-term increase in nitrate-N concentrations in the rivers and reservoirs upstream of the Delta, in the Delta Region, or the waters exported to the CVP and SWP service areas under Alternative 2A LLT relative to existing conditions. As such, this alternative is not expected to cause additional exceedance of applicable water quality objectives/criteria by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. Because nitrate concentrations are not expected to increase substantially, no long-term water quality degradation is expected to occur and, thus, no adverse effects to beneficial uses would occur. Nitrate is not 303(d) listed within the affected environment and thus any increases than may occur in some areas and months would not make any existing nitrate-related impairment measurably worse because no such impairments currently exist. Because nitrate is not bioaccumulative, increases that may occur in some areas and months would not bioaccumulate to greater levels in aquatic organisms that would, in turn, pose substantial health risks to fish, wildlife, or humans. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-16: Effects on nitrate concentrations resulting from implementation of CM2–23

Effects of CM2–23 on nitrate under Alternative 2A LLT are the same as those discussed for Alternative 1A LLT. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-17: Effects on dissolved organic carbon concentrations resulting from facilities operations and maintenance (CM1)

Upstream of the Delta

Under Alternative 2A LLT, there would be no substantial change to the sources of DOC within the watersheds upstream of the Delta. Moreover, long-term average flow and DOC levels in the Sacramento River at Hood and San Joaquin River at Vernalis are poorly correlated. Thus changes in system operations and resulting reservoir storage levels and river flows would not be expected to cause a substantial long-term change in DOC concentrations in the water bodies upstream of the Delta. Any negligible changes in DOC levels in water bodies upstream of the Delta under Alternative 2A LLT, relative to existing conditions and the No Action Alternative NT and LLT, would not be of sufficient frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the quality of these water bodies, with regards to DOC.

Delta

Under Alternative 2A LLT, the geographic extent of effects pertaining to long-term average DOC concentrations in the Delta would be similar to that previously described for Alternative 1A LLT, although the magnitude of predicted long-term change and relative frequency of concentration threshold exceedances would be slightly greater. Modeled effects would be greatest at Franks Tract, Rock Slough, and Contra Costa PP No. 1., where for the 16-year hydrologic period and the modeled drought period, long-term average concentration increases ranging from 0.3-0.4 mg/L would be predicted (≤12% net increase) (Appendix 8K, DOC Table 3). Increases in long-term average concentrations would correspond to more frequent concentration threshold exceedances, with the greatest change occurring at Rock Slough and Contra Costa PP No. 1 locations. For Rock Slough, long-term average DOC concentrations exceeding 3 mg/L would increase from 52% under existing conditions to 74% under the Alternative 2A LLT (an increase from 47% to 70% for the drought period), and concentrations exceeding 4 mg/L would increase from 30% to 36% (32% to 38% for the drought period). For Contra Costa PP No. 1, long-term average DOC concentrations exceeding 3 mg/L would increase from 52% under existing conditions to 80% under Alternative 2A LLT 45% to 80% for the drought period), and concentrations exceeding 4 mg/L would increase from 32% to 41% (35% to 42% for the drought period). Relative change in frequency of threshold exceedance for other assessment locations would be similar or less. While Alternative 2A LLT would generally lead to slightly higher long-term average DOC concentrations (≤0.4 mg/L) at some municipal water intakes and Delta interior locations, the predicted change would not be expected to adversely affect MUN beneficial uses, or any other beneficial use.

In comparison, Alternative 2A LLT relative to the No Action Alternative NT and No Action Alternative LLT would generally result in a similar magnitude of change to that discussed for the comparison to existing conditions. Maximum increases of 0.3–0.4 mg/L DOC (i.e., ≤12%) would be predicted at Franks Tract, Rock Slough, and Contra Costa PP No. 1 relative to No Action Alternative NT, while maximum increases at these locations would be slightly less (i.e., between 0.2-0.3 mg/L) when compared to No Action Alternative LLT (Appendix 8K, DOC Table 3). Threshold concentration exceedance frequency trends would also be similar to that discussed for the existing condition comparison, with exception to the predicted 4 mg/L exceedance frequency at Buckley Cove. In comparison to the No Action Alternative NT, the frequency which long-term average DOC concentrations exceeded 4 mg/L at Buckley Cove would increase from 23% to 28% (37% to 50% for the modeled drought period), with slightly smaller increases when comparing to No Action Alternative LLT. While the Alternative 2A LLT would generally lead to slightly higher long-term average DOC concentrations at some Delta assessment locations when compared to No Action Alternative NT and No Action Alternative LLT conditions, the predicted change would not be expected to adversely affect MUN beneficial uses, or any other beneficial use, particularly when considering the relatively small change in long-term annual average concentration.

As discussed for Alternative 1A, substantial change in ambient DOC concentrations would need to occur before significant changes in drinking water treatment plant design or operations are triggered. The increases in long-term average DOC concentrations estimated to occur at various Delta locations under Alternative 2A are of sufficiently small magnitude that they will not require existing drinking water treatment plants to substantially upgrade treatment for DOC removal above levels currently employed.

Relative to existing, No Action Alternative NT, and No Action Alternative LLT conditions, Alternative 2A LLT would lead to predicted improvements in long-term average DOC concentrations at Barker Slough, Banks and Jones pumping plants. At these locations, long-term average DOC concentrations would be predicted to decrease by as much as <0.1 - 0.5 mg/L, depending on baseline comparison.

SWP/CVP Export Service Areas

Under Alternative 2A LLT, modeled long-term average DOC concentrations would decrease at Banks and Jones pumping plants for both the modeled 16-year hydrologic period and the modeled drought period. Relative to existing conditions, long-term average DOC concentrations at Banks would be predicted to decrease by 0.5 mg/L (0.2 mg/L during drought period) (Appendix 8K, DOC Table 3). At Jones, long-term average DOC concentrations would be predicted to decrease by 0.4 mg/L (<0.1 mg/L during drought period). Predicted decreases under No Action Alternative NT and No Action Alternative LLT comparisons would be of similar magnitude. Such decreases in long-term average DOC would result in generally lower exceedance frequencies for concentration thresholds, although the frequency of exceedance during the modeled drought period (i.e., 1987-1991) would be predicted to increase. For the Banks pumping plant during the drought period, exceedance of the 3 mg/L threshold would increase from 57% under existing conditions to 84% under Alternative 2A LLT, while at the Jones pumping plant, exceedance frequency would increase from 72% to 88%. There would be comparatively fewer increases in the frequency of exceeding the 4 mg/L threshold at Banks and Jones. Comparisons to No Action Alternative NT and No Action Alternative LLT yield similar trends, but with slightly smaller magnitude drought period changes. Overall, modeling results for the SWP/CVP Export Service Areas predict an overall improvement in Export Service Areas water quality, although more frequent exports of >3mg/L DOC water would likely occur for drought periods.

Similar to the discussion pertaining to the No Action Alternative LLT, maintenance of SWP and CVP facilities under Alternative 2A LLT would not be expected to create new sources of DOC or contribute towards a substantial change in existing sources of DOC in the affected area. Maintenance activities would not be expected to cause any substantial change in long-term average DOC concentrations such that MUN beneficial uses, or any other beneficial use, would be adversely affected.

CEQA Conclusion: Relative to existing conditions, Alternative 2A LLT operation and maintenance would not result in any substantial change in long-term average DOC concentration upstream of the Delta or result in substantial increase in the frequency with which long-term average DOC concentrations exceeds 2, 3, or 4 mg/L levels at the 11 assessment locations analyzed for the Delta. Modeled long-term average DOC concentrations would increase by no more than 0.4 mg/L at any single Delta assessment location (i.e., ≤12% relative increase), with long-term average concentrations estimated to remain at or below 4.0 mg/L at all Delta locations assessed, with the exception of Buckley Cove on the San Joaquin River during the drought period modeled. Nevertheless, long-term average concentrations at Buckley Cove are expected to decrease slightly during the drought period, relative to existing conditions. The increases in long-term average DOC concentration that could occur within the Delta would not be of sufficient magnitude to adversely affect the MUN beneficial use, or any other beneficial uses, of Delta waters or waters of the SWP/CVP Service Area. Because DOC is not bioaccumulative, the increases in long-term average DOC concentrations would not directly cause bioaccumulative problems in aquatic life or humans. Finally, DOC is not causing beneficial use impairments and thus is not 303(d) listed for any water body within the affected environment. Thus, the increases in long-term average DOC that could occur at various locations would not make any beneficial use impairment measurably worse. Because long-term average DOC concentrations are not expected to increase substantially, no long-term water quality degradation with respect to DOC is expected to occur and, thus, no adverse effects on beneficial uses would occur. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-18: Effects on dissolved organic carbon concentrations resulting from implementation of CM2–23

Conservation components proposed under Alternative 2A would be the same as those proposed under Alternative 1A. As such, effects on DOC resulting from the implementation of CM2–23 would be similar to that previously discussed for Alternative 1A LLT. In summary, conservation measures CM4–7 and CM10 could contribute substantial amounts of DOC to raw drinking water supplies, largely depending on final design and operational criteria for the related wetland and riparian habitat restoration activities. Substantially increased long-term average DOC in raw water supplies could lead to a need for treatment plant upgrades in order to appropriately manage DBP formation in treated drinking water. This potential for future DOC increases would lead to substantially greater associated risk of long-term adverse effects on the MUN beneficial use.

CEQA Conclusion: Effects of CM4–7 and CM10 on DOC under Alternative 2A LLT would be similar to those discussed for Alternative 1A LLT. This impact is considered to be significant and mitigation is required. It is uncertain whether implementation of Mitigation Measure WQ-18 would reduce identified impacts to a less than significant level. Hence, this impact could remain significant after mitigation.

Mitigation Measure WQ-18: Design wetland and riparian habitat features to minimize effects on municipal intakes

Please see Mitigation Measure WQ-18 under Impact WQ-18 in the discussion of Alternative 1A.

Impact WQ-19: Effects on pathogens resulting from facilities operations and maintenance

Effects of CM1 on pathogens under Alternative 2A LLT are the same as those discussed for Alternative 1A LLT. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-20: Effects on pathogens resulting from implementation of CM2–CM22

Effects of CM2–23 on pathogens under Alternative 2A LLT are the same as those discussed for Alternative 1A LLT. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-21: Effects on pesticide concentrations resulting from facilities operations and maintenance (CM1)

Upstream of the Delta

For the same reasons stated for the No Action Alternative LLT, under Alternative 2A LLT no specific operations or maintenance activity of the SWP or CVP would substantially drive a change in pesticide use, and thus pesticide sources would remain unaffected upstream of the Delta. Nevertheless, changes in the timing and magnitude of reservoir releases could have an effect on available dilution capacity along river segments such as the Sacramento, Feather, American, and San Joaquin Rivers.

Under Alternative 2A LLT, winter (November –March)and summer (April – October) season average flow rates on the Sacramento River at Freeport, American River at Nimbus, Feather River at Thermalito and the San Joaquin River at Vernalis would change. Relative to existing condition, No Action Alternative NT and No Action Alternative LLT, seasonal average flow rates on the Sacramento would decrease no more than 5% during the summer and 4% during the winter relative to existing conditions (Appendix 8L, Seasonal average flows Table 1-4). On the Feather River, average flow rates would decrease no more than 2% during the summer and winter, while on the American River average flow rates would decrease by as much as 15% in the summer but would increase by as much as 9% in the winter. Seasonal average flow rates on the San Joaquin River would decrease by as much as 12% in the summer, but increase by as much as 3% in the winter. For the same reasons stated for the No Action Alternative LLT, decreased seasonal average flow of ≤15% is not considered to be of sufficient magnitude to substantially increase pesticide concentrations or alter the long-term risk of pesticide-related toxicity to aquatic life, nor adversely affect other beneficial uses of water bodies upstream of the Delta.

Delta

Sources of diuron, OP, and pyrethroid insecticides to the Plan Area include direct input of surface runoff from in-Delta agriculture and Delta urbanized areas as well inputs from rivers upstream of the Delta. Similar to Upstream of the Delta, CVP/SWP operations would not affect these sources.

Under Alternative 2A LLT, the distribution and mixing of Delta source waters would change. Percent change in monthly average source water fraction were evaluated for the modeled 16-year (1976-1991) hydrologic period and a representative drought period (1987-1991), with special attention given to changes in San Joaquin River, Sacramento River and Delta Agriculture sources water fractions. Relative to existing conditions, under Alternative 2A LLT modeled San Joaquin River fractions would increase greater than 10% at Buckley Cove (drought period only), Franks Tract, Rock Slough, and Contra Costa PP No. 1 (Appendix 8D, Source Water Fingerprinting). At Buckley Cove, San Joaquin River source water fractions when modeled for the drought period would increase 15% in August. At Franks Tract, source water fractions when modeled for the 16-year hydrologic period would increase 13-17% during October through November and February through April. At Rock Slough, San Joaquin River source water fractions would increase 11-24% during September through March (11-15% during October and November of the modeled drought period). Similarly, San Joaquin River fractions at Contra Costa Pumping Plant No. 1 would increase 10-24% during October through April (11-13% during October and November of the modeled drought period). While the modeled 24% increases of San Joaquin River Fraction at Rock Slough and Contra Costa PP No. 1 in November are considerable, the resultant net fraction would be ≤30%. Relative to existing conditions, there would be no modeled increases in Sacramento River fractions greater than 13% (with exception to Banks and Jones, discussed below) and Delta agricultural fractions greater than 8%. These modeled changes in the source water fractions of Sacramento, San Joaquin and Delta agriculture water are not of sufficient magnitude to substantially alter the long-term risk of pesticide-related toxicity to aquatic life, nor adversely affect other beneficial uses of the Delta.

When compared to No Action Alternative NT and No Action Alternative LLT, changes in source water fractions would be similar in season, geographic extent, and magnitude to those discussed for existing conditions with exception to Buckley Cove. At Buckley Cove, modeled San Joaquin River fractions would increase 16% in July (33% for the modeled drought period) and 25% in August (48% for the modeled drought period) when compared to No Action Alternative LLT (Appendix 8D, Source Water Fingerprinting). These increases would primarily balance through decreases in Sacramento River water and eastside tributary waters, and as a result the San Joaquin River would account for as much as 75% of the total source water volume at Buckley Cove in July and August (as much as 60% for the modeled drought period). While the source water and potential pesticide related toxicity co-occurrence predictions do not mean adverse effect would occur, such considerable modeled increases in summer source water fraction at Buckley Cove could substantially alter the long-term risk of pesticide-related toxicity to aquatic life, given the apparent greater incidence of pesticides in the San Joaquin River.

These predicted adverse effects on pesticides relative to No Action Alternative LLT fundamentally assume that the present pattern of pesticide incidence in surface water will occur at similar levels into the future. In reality, however, the makeup and character of the pesticide use market in the late long-term (i.e., the year 2060) will not be exactly as it is today. Current use of chlorpyrifos and diazinon is on the decline with their replacement by pyrethroids on the rise, yet in this assessment it is the apparent greater incidence of diazinon and chlorpyrifos on the San Joaquin River that serves as the basis for concluding that substantially increased San Joaquin River source water fraction would correspond to an increased risk of pesticide-related toxicity to aquatic life. By 2060, however, alternatives pesticides, such as neonicitinoids and biologicals, will likely be a more substantial contributing part of the existing mix of pesticides, and perhaps more prominent. The trend in the development of future-use pesticides is towards reduced risk pesticides, including more biopesticides, with greater targeted specificity, fewer residues, and lower overall non-target toxicity. By 2060 existing chlorpyrifos and diazinon TMDLs for the Sacramento and San Joaquin Rivers will have been in effect for more than 50 years. Moreover, it is reasonable to expect that CWA section 303(d) listings and future additional listings will have developed TMDLs by 2060. To the extent these existing and future TMDL's address current and future-use pesticides, a greater degree of pesticide related source control can be anticipated. Nevertheless, forecasting whether these various efforts will ultimately be successful at resolving current pesticide related impairments requires considerable speculation. While the fundamental assumptions that have guided this assessment of pesticides may be somewhat altered by 2060, these assumptions are informed by actual studies and monitoring data collected from the recent past and, therefore, judging project alternative effects in the future remain most accurate through use of these informed assumptions rather than based on assumptions founded upon future speculative conditions.

SWP/CVP Export Service Areas

Assessment of effects in SWP/CVP Export Service Areas is based on effects seen in the Plan Area at the Banks and Jones pumping plants. Under Alternative 2A LLT, Sacramento River source water fractions would increase substantially at both Banks and Jones pumping plants relative to existing conditions, No Action Alternative NT and No Action Alternative LLT (Appendix 8D, Source Water Fingerprinting). At Banks pumping plant, Sacramento source water fractions would generally increase from 23-50% for the period of January through June (22-25% for March through April of the modeled drought period) and at Jones pumping plant Sacramento source water fractions would generally increase from 34-59% for the period of January through June (16-51% for February through May of the modeled drought period). These increases in Sacramento source water fraction would primarily balance through equivalent decreases in San Joaquin River water. Based on the general observation that San Joaquin River, in comparison to the Sacramento River, is a greater contributor of OP insecticides in terms of greater frequency of incidence and presence at concentrations exceeding water quality benchmarks, modeled increases in Sacramento River fraction at Banks and Jones would generally represent an improvement in export water quality respective to pesticides.

CEQA Conclusion: Relative to existing conditions, the Alternative 2A LLT would not result in any substantial change in long-term average pesticide concentration or result in substantial increase in the anticipated frequency with which long-term average pesticide concentrations would exceed aquatic life toxicity thresholds or other beneficial use effect thresholds upstream of the Delta, at the 11 assessment locations analyzed for the Delta, or the SWP/CVP service area. Numerous pesticides are currently used throughout the affected environment, and while some of these pesticides may be bioaccumulative, those present-use pesticides for which there is sufficient evidence for their presence in waters affected by SWP and CVP operations (i.e., diazinon, chlorpyrifos, diuron, and pyrethroids) are not considered bioaccumulative, and thus changes in their concentrations would not directly cause bioaccumulative problems in aquatic life or humans. Furthermore, while there are numerous 303(d) listings throughout the affected environment that name pesticides as the cause for beneficial use impairment, the modeled changes in upstream river flows and Delta source water fractions would not be expected to make any of these beneficial use impairments measurably worse. Because long-term average pesticide concentrations are not expected to increase substantially, no long-term water quality degradation with respect to pesticides is expected to occur and, thus, no adverse effects on beneficial uses would occur. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-22: Effects on pesticide concentrations resulting from implementation of CM2–CM22

Conservation components proposed under Alternative 2A would be the same as those proposed under Alternative 1A. As such, effects on pesticides resulting from the implementation of CM2-CM22 would be similar to that previously discussed for Alternative 1A LLT. In summary, CM13 proposes the use of herbicides to control invasive aquatic vegetation around habitat restoration sites. Herbicides directly applied to water could include adverse effects on non-target aquatic life, such as aquatic invertebrates and beneficial aquatic plants. As such, aquatic life toxicity objectives could be exceeded with sufficient frequency and magnitude such that beneficial uses would be impacted.

CEQA Conclusion: Effects of CM2-CM22 on pesticides under Alternative 2A LLT are the similar as those discussed for Alternative 1A LLT. Potential environmental effects related only to CM13 are considered to be significant. Mitigation is required. While Mitigation Measure WQ-22 is available to partially reduce this impact of pesticides, no feasible mitigation is available that would reduce it to a level that would be less than significant.

Mitigation Measure WQ-22: Implement least toxic integrated pest management strategies

Please see Mitigation Measure WQ-22 under Impact WQ-22 in the discussion of Alternative 1A.

Impact WQ-23: Effects on phosphorus concentrations resulting from facilities operations and maintenance (CM1)

Effects of water facilities and operations (CM1) on phosphorus levels in water bodies of the affected environment under Alternative 2A LLT would be very similar (i.e., nearly the same) as those discussed for Alternative 1A LLT. Consequently, the environmental consequences to phosphorus levels discussed in detail for Alternative 1A LLT also adequately represent the effects under Alternative 2A LLT. Based on this finding, this impact is considered to be less than significant. No mitigation is required.

Impact WQ-24: Effects on phosphorus concentrations resulting from implementation of CM2–CM22

Effects of CM2–23 on phosphorus levels in water bodies of the affected environment under Alternative 2A LLT would be very similar (i.e., nearly the same) as those discussed for Alternative 1A LLT. Consequently, the environmental consequences to phosphorus levels from implementing CM2-CM22 discussed in detail for Alternative 1A LLT also adequately represent the effects of these same actions under Alternative 2A LLT. Based on this finding, this impact is considered to be less than significant. No mitigation is required.

Impact WQ-25: Effects on selenium concentrations resulting from facilities operations and maintenance (CM1)

[*Note to Lead Agencies: This assessment is in preparation*].

Impact WQ-26: Effects on selenium concentrations resulting from implementation of CM2–CM22

[*Note to Lead Agencies: This assessment is in preparation*].

Impact WQ-27: Effects on trace metal concentrations resulting from facilities operations and maintenance (CM1)

Upstream of the Delta

For the same reasons stated for the No Action Alternative LLT, Alternative 2A LLT would result in negligible, and likely immeasurable, increases in trace metal concentrations in the rivers and reservoirs upstream of the Delta, relative to existing conditions, No Action NT and No Action LLT. Effects due to the operation and maintenance of the conveyance facilities are expected to be immeasurable, on an annual and long-term average basis. As such, the Alternative 2A would not be expected to substantially increase the frequency with which applicable Basin Plan objectives or CTR criteria would be exceeded in water bodies of the affected environment located upstream of the Delta or substantially degrade the quality of these water bodies, with regard to trace metals.

Delta

For the same reasons stated for the No Action Alternative LLT, Alternative 2A LLT would not result in substantial increases in trace metal concentrations in the Delta relative to existing conditions, No Action NT, and No Action LLT. Effects due to the operation and maintenance of the conveyance facilities are expected to be negligible, on long-term average basis. As such, Alternative 2A would not be expected to substantially increase the frequency with which applicable Basin Plan objectives or CTR criteria would be exceeded in the Delta or substantially degrade the quality of Delta waters, with regard to trace metals.

SWP/CVP Export Service Areas

For the same reasons stated for the No Action Alternative LLT, Alternative 2A LLT would not result in substantial increases in trace metal concentrations in the water exported from the Delta or diverted from the Sacramento River through the proposed conveyance facilities. As such, there is not expected to be substantial changes in trace metal concentrations in the SWP/CVP export service area waters under Alternative 2A, relative to existing conditions, No Action NT, and No Action LLT. As such, Alternative 2A would not be expected to substantially increase the frequency with which applicable Basin Plan objectives or CTR criteria would be exceeded in the water bodies of the affected environment in the SWP and CVP Service Area or substantially degrade the quality of these water bodies, with regard to trace metals.

CEQA Conclusion: There would be no substantial long-term increase in trace metal concentrations in the rivers and reservoirs upstream of the Delta, in the Delta Region, or the SWP/CVP export service area waters under Alternative 2A relative to existing conditions. As such, this alternative is not expected to cause additional exceedance of applicable water quality objectives by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. Because trace metal concentrations are not expected to increase substantially, no long-term water quality degradation for trace metals is expected to occur and, thus, no adverse effects to beneficial uses would occur. Furthermore, any negligible changes in long-term trace metal concentrations that may occur in water bodies of the affected environment would not be expected to make any existing beneficial use impairments measurably worse. The trace metals discussed in this assessment are not considered bioaccumulative, and thus would not directly cause bioaccumulative problems in aquatic life or humans. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-28: Effects on trace metal concentrations resulting from implementation of CM2–CM22

Conservation components proposed under Alternative 2A would be the same as those proposed under Alternative 1A. As such, effects on trace metals resulting from the implementation of CM2-CM22 would be similar to that previously discussed for Alternative 1A. As they pertain to trace metals, implementation of CM2-CM22 would not be expected to adversely affect beneficial uses of the affected environment or substantially degrade water quality with respect to trace metals.

CEQA Conclusion: Implementation of CM2-CM22 under Alternative 2A would not cause substantial long-term increase in trace metal concentrations in the rivers and reservoirs upstream of the Delta, in the Delta Region, or the SWP/CVP export service area. As such, this alternative is not expected to cause additional exceedance of applicable water quality objectives by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. Because trace metal concentrations are not expected to increase substantially, no long-term water quality degradation for trace metals is expected to occur and, thus, no adverse effects to beneficial uses would occur. Furthermore, any negligible changes in long-term trace metal concentrations that may occur throughout the affected environment would not be expected to make any existing beneficial use impairments measurably worse. The trace metals discussed in this assessment are not considered bioaccumulative, and thus would not directly cause bioaccumulative problems in aquatic life or humans. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-29: Effects on TSS and turbidity resulting from facilities operations and maintenance (CM1)

Effects of CM1 on TSS and turbidity under Alternative 2A LLT are the same as those discussed for Alternative 1A LLT. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-30: Effects on TSS and turbidity resulting from implementation of CM2–CM22

Effects of CM2–CM22on TSS and turbidity under Alternative 2A LLT are the same as those discussed for Alternative 1A LLT. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-31: Water quality effects resulting from construction-related activities

The conveyance features for CM1 under Alternative 2A would be very similar to those discussed for Alternative 1A. The primary difference between Alternative 2A and Alternative 1A is that under Alternative 2A, some adjustments of the intake and intermediate pumping plant locations would occur. As such, construction techniques and locations of major features of the conveyance system within the Delta would be similar. The remainder of the facilities constructed under Alternative 2A, including conservation measures CM2-CM22, would be very similar to, or the same as, those to be constructed for Alternative 1A.

The types and magnitude of potential construction-related water quality effects associated with implementation of conservation measures CM1 under Alternative 2A would be very similar to the effects discussed for Alternative 1A LLT, and the effects anticipated with implementation of CM2-CM22 would be essentially identical. Nevertheless, the construction of CM1 with the environmental commitments and agency permitted construction requirements and BMPs would result in the potential water quality effects being largely avoided and minimized. The specific environmental commitments that would be implemented under Alternative 2A would be similar to those described for Alternative 1A. Consequently, relative to existing conditions, Alternative 2A LLT would not be expected to cause exceedance of applicable water quality objectives/criteria or substantial water quality degradation with respect to constituents of concern, and thus would not adversely affect any beneficial uses upstream of the Delta, in the Delta, or in the SWP and CVP service area.

***CEQA Conclusion*:** Construction-related contaminant discharges would be temporary and intermittent in nature and would involve negligible, if any, discharges of bioaccumulative or 303(d) listed constituents to water bodies of the affected environment. As such, construction activities would not contribute measurably to bioaccumulation of contaminants in organisms or humans or cause 303(d) impairments to be discernibly worse. Because environmental commitments would be implemented under Alternative 2A LLT for construction-related activities along with agency-issues permits that also contain construction requirements to protect water quality, the construction-related effects would not be expected to cause or contribute to a substantial increased frequency of exceedances of water quality objectives/criteria relative to existing conditions, or substantially degrade water quality with respect to the constituents of concern on a long-term average basis, and thus would not adversely affect any beneficial uses in water bodies upstream of the Delta, within the Delta, or in the SWP and CVP service area. Based on these findings, this impact is determined to be less than significant. No mitigation is required.

8.3.4.6 Alternative 2B—Dual Conveyance with East Canal and Five Intakes

Alternative 2B would be identical to Alternative 2A except that the up to 15,000 cfs of water routed from the north Delta to the south Delta would be conveyed through a canal along the east side of the Delta instead of through through pipelines/tunnels (i.e., CM1 differs). CM2–CM22 would be implemented under this alternative, and these conservation measures would be the same as those under Alternative 1A. See Chapter 3, *Description of Alternatives*, for additional details on Alternative 2B.

Water Quality Effects Resulting from Facilities Operations and Maintenance (CM1)

Alternative 2B has the same diversion and conveyance operations and conservation measures as Alternative 2A. The primary difference between the two alternatives is that conveyance under Alternative 2B would be in a lined or unlined canal, instead of pipeline. Because there would be no difference in conveyance capacity or operations, there would be no differences between these two alternatives in upstream of the Delta river flows or reservoir operations, Delta inflow, source fractions to various Delta locations, and hydrodynamics in the Delta. Conveyance of water in an open channel instead of a pipeline may result in differing physical properties (e.g., DO, pH, temperature) of the water upon reaching the south Delta export pumps than if the water was conveyed in a pipeline. However, the physical properties of water arriving at the south Delta export pumps would continue to change and would equilibrate to similar levels as Alternative 2A as it is conveyed throughout the SWP/CVP Export Service Areas. Because no substantial differences in water quality effects are anticipated anywhere in the affected environment under Alternative 2B compared to those described in detail for Alternative 2A, the water quality effects described for Alternative 2A also appropriately characterize effects under Alternative 2B.

Water Quality Effects Resulting from Implementation of CM2–CM22

Alternative 2B has the same conservation measures as Alternative 2A Because no substantial differences in water quality effects are anticipated anywhere in the affected environment under Alternative 2B compared to those described in detail for Alternative 2A, the water quality effects described for Alternative 2A also appropriately characterize effects under Alternative 2B.

Water Quality Effects Resulting from Construction

The primary difference between Alternative 2B and Alternative 1A is that under Alternative 2B, a canal would be constructed for conservation measure CM1 along the eastern side of the Delta to convey the Sacramento River water south, rather than the tunnel/pipeline features. As such, construction techniques and locations of major features of the conveyance system within the Delta would be different. The remainder of the facilities constructed under Alternative 2B, including conservation measures CM2–CM22, would be very similar to, or the same as, those to be constructed for Alternative 1A.

The types of potential construction-related water quality effects associated with implementation of conservation measures CM1 under Alternative 2B would be very similar to the effects discussed for Alternative 1A LLT, and the effects anticipated with implementation of CM2-CM22 would be essentially identical. Given the substantial differences in the conveyance features under CM1 with construction of canal, there could be differences in the location, magnitude, duration, and frequency of construction activities and related water quality effects. In particular, relative to the existing conditions and No Action Alternative conditions, construction of the major canal features for CM1 under Alternative 2B LLT would involve extensive general construction activities, material handling/storage/placement activities, surface soil grading/excavation/disposal and associated exposure of disturbed sites to erosion and runoff, and construction site dewatering operations. Nevertheless, the construction of CM1 with the environmental commitments and agency permitted construction requirements and BMPs would result in the potential water quality effects being largely avoided and minimized. The specific environmental commitments that would be implemented under Alternative 2B would be similar to those described for Alternative 1A. Consequently, relative to existing conditions, Alternative 2B LLT would not be expected to cause exceedance of applicable water quality objectives/criteria or substantial water quality degradation with respect to constituents of concern, and thus would not adversely affect any beneficial uses upstream of the Delta, in the Delta, or in the SWP and CVP service area. Alternative 2C—Dual Conveyance with West Canal and Intakes W1-W5 (15,000 cfs; Operational Scenario B)

Alternative 2C would be identical to Alternative 2A except that the up to 15,000 cfs of water routed from the north Delta to the south Delta would be conveyed through a canal/tunnel along the west side of the Delta instead of through pipelines/tunnels. CM2-CM22 would be implemented under this alternative, and these conservation measures would be the same as those under Alternative 1A. See Chapter 3, *Description of Alternatives*, for additional details on Alternative 2C.

Water Quality Effects Resulting from Facilities Operations and Maintenance (CM1)

Alternative 2C has the same diversion and conveyance operations and conservation measures as Alternative 2A. The primary differences between the two alternatives is that conveyance under Alternative 2C would be in a lined or unlined canal, instead of pipeline, and the alignment of the canal would be along the western side of the Delta, rather than the eastern side. Because there would be no difference in conveyance capacity or operations, there would be no differences between these two alternatives in upstream of the Delta river flows or reservoir operations, Delta inflow, source fractions to various Delta locations, and hydrodynamics in the Delta. Conveyance of water in an open channel instead of a pipeline may result in differing physical properties (e.g., DO, pH, temperature) of the water upon reaching the south Delta export pumps than if the water was conveyed in a pipeline. However, the physical properties of water arriving at the south Delta export pumps would continue to change and would equilibrate to similar levels as Alternative 2A as it is conveyed throughout the SWP/CVP Export Service Areas. Because no substantial differences in water quality effects are anticipated anywhere in the affected environment under Alternative 2C compared to those described in detail for Alternative 2A, the water quality effects described for Alternative 2A also appropriately characterize effects under Alternative 2C.

Water Quality Effects Resulting from Implementation of CM2–CM22

Alternative 2C has the same conservation measures as Alternative 2A. Because no substantial differences in water quality effects are anticipated anywhere in the affected environment under Alternative 2C compared to those described in detail for Alternative 2A, the water quality effects described for Alternative 2A also appropriately characterize effects under Alternative 2C.

Water Quality Effects Resulting from Construction

The primary difference between Alternative 2C and Alternative 1A is that under Alternative 2C, a canal would be constructed for conservation measure CM1 along the western side of the Delta to convey the Sacramento River water south, in addition to the tunnel/pipeline features. As such, construction techniques and locations of major features of the conveyance system within the Delta would be different. The remainder of the facilities constructed under Alternative 2C, including conservation measures CM2–CM22, would be very similar to, or the same as, those to be constructed for Alternative 1A.

The types of potential construction-related water quality effects associated with implementation of conservation measures CM1 under Alternative 2C would be very similar to the effects discussed for Alternative 1A LLT, and the effects anticipated with implementation of CM2-CM22 would be essentially identical. Given the substantial differences in the conveyance features under CM1 with construction of canal in addition to the tunnel/pipeline features, there could be differences in the location, magnitude, duration, and frequency of construction activities and related water quality effects. In particular, relative to the existing conditions and No Action Alternative conditions, construction of the major canal features for CM1 under Alternative 2C LLT would involve extensive general construction activities, material handling/storage/placement activities, surface soil grading/excavation/disposal and associated exposure of disturbed sites to erosion and runoff, and construction site dewatering operations. Nevertheless, the construction of CM1 with the environmental commitments and agency permitted construction requirements and BMPs would result in the potential water quality effects being largely avoided and minimized. The specific environmental commitments that would be implemented under Alternative 2C would be similar to those described for Alternative 1A. However, this alternative would involve environmental commitments associated with both tunnel/pipeline and canal construction activities.Consequently, relative to existing conditions, Alternative 2C LLT would not be expected to cause exceedance of applicable water quality objectives/criteria or substantial water quality degradation with respect to constituents of concern, and thus would not adversely affect any beneficial uses upstream of the Delta, in the Delta, or in the SWP and CVP service areaAlternative 3—Dual Conveyance with Tunnel and Intakes 1 and 2 (6,000 cfs; Operational Scenario A)

Alternative 3 would convey up to 6,000 cfs of water from the north Delta to the south Delta through pipelines/tunnels from two screened intakes on the east bank of the Sacramento River between Clarksburg and Walnut Grove. A new Byron Tract Forebay, adjacent to and south of Clifton Court Forebay, would be constructed which would provide water to the south Delta pumping plants. Water supply and conveyance operations would follow the guidelines described as Scenario A, which does not include fall X2. Conservation measures 2-23 (CM2-23) would be implemented under this alternative, and would be the same as those under Alternative 1A. See Chapter 3 (Description of Alternatives) for additional details on Alternative 3.

ImpactWQ-1: Effects on ammonia concentrations resulting from facilities operations and maintenance (CM1)

Upstream of the Delta

For the same reasons stated for the No Action Alternative LLT, Alternative 3 LLT would have negligible, if any, effect on ammonia concentrations in the rivers and reservoirs upstream of the Delta relative to existing conditions and the No Action Alternative NT and LLT. Any negligible increases in ammonia-N concentrations that could occur in the water bodies of the affected environment located upstream of the Delta would not be of frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the quality of these water bodies, with regard to ammonia.

Delta

Assessment of effects of ammonia under Alternative 3 LLT is the same as discussed under Alternative 1A, except that because flows in the Sacramento River at Freeport are different between the two alternatives, estimated monthly average and long term annual average predicted ammonia-N concentrations in the Sacramento River downstream of Freeport are different.

As Table 8-56 shows, estimated ammonia-N concentrations in the Sacramento River downstream of Freeport (upon full mixing of the SRWTP discharge with river water) under Alternative 3 LLT and the No Action Alternative LLT are expected to be similar. Minor increases in ammonia-N concentrations would occur during July through September and in November, and remaining months would be unchanged or have a minor decrease. Annual average concentrations would be the same under both Alternative 3 LLT and the No Action Alternative LLT. Moreover, the estimated concentrations downstream of Freeport under Alternative 3 LLT would be similar to existing source water concentrations for the San Francisco Bay and San Joaquin River. Consequently, changes in source water fraction anticipated under Alternative 3 LLT, relative to the No Action Alternative LLT, are not expected to substantially increase ammonia concentrations at any Delta locations.

Any negligible increases in ammonia-N concentrations that could occur at certain locations in the Delta would not be of frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the water quality at these locations, with regards to ammonia.

Table 8-56. Estimated Ammonia-N (mg-L as N) Concentrations in the Sacramento River Downstream of the Sacramento Regional Wastewaster Treatment Plant for the No Action Alternative LLT and Alternative 3 LLT

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual Average
No Action Alternative LLT	0.081	0.073	0.061	0.055	0.053	0.055	0.061	0.070	0.072	0.064	0.072	0.069	0.063
Alternative 3 LLT	0.074	0.077	0.061	0.055	0.053	0.055	0.061	0.067	0.068	0.069	0.079	0.084	0.063

SWP/CVP Export Service Areas

The assessment of effects on ammonia in the SWP/CVP Export Service Area is based on assessment of ammonia-N concentrations at Banks and Jones pumping plants. Similar to the discussion for Alternative 1A, under Alternative 3 for areas of the Delta that are influenced by Sacramento River water, including Banks and Jones pumping plants, ammonia-N concentrations are expected to decrease, relative to existing conditions and No Action Alternative NT. This decrease in ammonia-N concentrations for water exported via the south Delta pumps is not expected to result in an adverse effects on beneficial uses or substantially degrade water quality of exported water, with regards to ammonia.

Furthermore, as discussed above for the PlanArea, for all areas of the Delta, including Banks and Jones pumping plants, ammonia-N concentrations are not expected to be substantially different under Alternative 3 LLT, relative to No Action Alternative LLT. Any negligible increases in ammonia-N concentrations that could occur at Banks and Jones pumping plants would not be of frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the water quality at these locations, with regards to ammonia.

***CEQA Conclusion*:** There would be no substantial, long-term increase in ammonia-N concentrations in the rivers and reservoirs upstream of the Delta, in the PlanArea, or the waters exported to the CVP and SWP service areas under Alternative 3 LLT relative to existing conditions. As such, this alternative is not expected to cause additional exceedance of applicable water quality objectives/criteria by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. Because ammonia concentrations are not expected to increase substantially, no long-term water quality degradation is expected to occur and, thus, no adverse effects on beneficial uses would occur. Ammonia is not 303(d) listed within the affected environment and thus any minor increases than could occur in some areas would not make any existing ammonia-related impairment measurably worse because no such impairments currently exist. Because ammonia-N is not bioaccumulative, minor increases that could occur in some areas would not bioaccumulate to greater levels in aquatic organisms that would, in turn, pose substantial health risks to fish, wildlife, or humans. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-2: Effects on ammonia concentrations resulting from implementation of CM2–CM22

Effects of CM2–CM22on ammonia under Alternative 3 LLT are the same as those discussed for Alternative 1A LLT. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-3: Effects on boron concentrations resulting from facilities operations and maintenance (CM1)

Upstream of the Delta

Effects of CM1 on boron under Alternative 3A LLT in areas upstream of the Delta would be very similar to the effects discussed for Alternative 1A LLT. There would be no expected change to the sources of boron in the Sacramento and east-side tributary watersheds, and resultant changes in flows from altered system-wide operations would have negligible, if any, effects on the concentration of boron in the rivers and reservoirs of these watersheds. The modeled long-term annual average lower San Joaquin River flow at Vernalis would decrease slightly compared to existing conditions and the No Action Alternative NT, and would be similar compared to the No Action Alternative LLT. The reduced flow would result in possible increases in long-term average boron concentrations of up to about 3% relative to the existing conditions and No Action Alternative NT conditions. The increased boron concentrations would not increase the frequency of exceedances of any applicable objectives or criteria and would not be expected to cause further degradation at measurable levels in the lower San Joaquin River, and thus would not cause the existing impairment there to be discernibly worse. Consequently, Alternative 3A LLT would not be expected to cause exceedance of boron objectives/criteria or substantially degrade water quality with respect to boron, and thus would not adversely affect any beneficial uses of the Sacramento River, the east-side tributaries, associated reservoirs upstream of the Delta, or the San Joaquin River.

Delta

Effects of CM1 on boron under Alternative 3A LLT in the Delta would be very similar to the effects discussed for Alternative 1A LLT. Relative to the existing conditions, No Action Alternative NT, and No Action Alternative LLT, Alternative 3A LLT would result in similar or reduced long-term average boron concentrations for the 16-year period modeled at northern and eastern Delta locations, and would increase at interior and western Delta locations (by as much as 8% at the SF Mokelumne River at Staten Island, 9% at Franks Tract, 7% at Old River at Rock Slough, and 7% at the Sacramento River at Emmaton) (Appendix 8F, Table Bo-10). Implementation of tidal habitat restoration under conservation measure CM4 also may contribute to increased boron concentrations at western Delta assessment locations, and thus would not be anticipated to substantially affect agricultural diversions which occur primarily at interior Delta locations. The long-term annual average and monthly average boron concentrations, for either the 16-year period or drought period modeled, would never exceed the 2,000 μg/L human health advisory objective (i.e., for children) or 500 μg/L agricultural objective at any of the eleven Delta assessment locations, which represents no change from the existing conditions and No Action Alternative NT and LLT conditions (Appendix 8F, Table Bo-3). Reductions in long-term average assimilative capacity of up to 4% at interior Delta locations (i.e., Franks Tract and Old River at Rock Slough) would be small with respect to the 500 μg/L agricultural objective (Appendix 8F, Table Bo-11). However, because the absolute boron concentrations would still be well below the lowest 500 μg/L objective for the protection of the agricultural beneficial use under Alternative 3A LLT, the levels of boron degradation would not be of sufficient magnitude to substantially increase the risk of exceeding objectives or cause adverse effects to municipal and agricultural water supply beneficial uses, or any other beneficial uses, in the Delta (Appendix 8F, Figure Bo-2).

SWP/CVP Export Service Areas

Effects of CM1 on boron under Alternative 3A LLT in the Delta would be very similar to the effects discussed for Alternative 1A LLT. Under Alternative 3A LLT, long-term average boron concentrations would decrease by as much as 15% at the Banks Pumping Plant and by as much 14% at Jones Pumping Plant relative to existing conditions, No Action Alternative NT, and No Action Alternative LLT (Appendix 8F, Table Bo-10). Commensurate with the decrease in exported boron concentrations, boron concentrations in the lower San Joaquin River may be reduced and would likely alleviate or lessen any expected increase in boron concentrations at Vernalis associated with flow reductions (see discussion of Upstream of the Delta), as well locations in the Delta receiving a large fraction of San Joaquin River water. Reduced export boron concentrations also may contribute to reducing the existing 303(d) impairment in the lower San Joaquin River and associated TMDL actions for reducing boron loading.

Maintenance of SWP and CVP facilities under Alternative 3A LLT would not be expected to create new sources of boron or contribute towards a substantial change in existing sources of boron in the affected environment. Maintenance activities would not be expected to cause any substantial increases in boron concentrations or degradation with respect to boron such that objectives would be exceeded more frequently, or any beneficial uses would be adversely affected anywhere in the affected environment.

***CEQA Conclusion*:** Boron is not a bioaccumulative constituent, thus any increased concentrations under Alternative 3A LLT would not result in adverse boron bioaccumulation effects to aquatic life or humans. Relative to existing conditions, Alternative 3A LLT would not result in any substantial increases in boron concentration upstream of the Delta. Alternative 3A LLT maintenance also would not result in any substantial increases in boron concentrations in the affected environment. Relative to existing conditions, Alternative 3A LLT would not result in substantially increased boron concentrations such that frequency of exceedances of municipal and agricultural water supply objectives would increase. The levels of boron degradation that may occur under Alternative 3A LLT would not be of sufficient magnitude to cause substantially increased risk for adverse effects to municipal or agricultural beneficial uses within the affected environment. Long-term average boron concentrations would decrease in Delta water exports to the SWP and CVP service area, which may contribute to reducing the existing 303(d) impairment of agricultural beneficial uses in the lower San Joaquin River. Based on these findings, this impact is determined to be less than significant. No mitigation is required.

Impact WQ-4: Effects on boron concentrations resulting from implementation of CM2–CM22

Effects of CM2-CM22 on boron under Alternative 3A LLT are the same as those discussed for Alternative 1A LLT. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-5: Effects on bromide concentrations resulting from facilities operations and maintenance (CM1)

Upstream of the Delta

Under Alternative 3 LLT there would be no expected change to the sources of bromide in the Sacramento and eastside tributary watersheds. Bromide loading in these watersheds would remain unchanged and resultant changes in flows form altered system-wide operations under Alternative 3 LLT would have negligible, if any, effects on the concentration of bromide in the rivers and reservoirs of these watersheds. Consequently, Alternative 3 LLT would not be expected to adversely affect the MUN beneficial use, or any other beneficial uses, of the Sacramento River, the eastside tributaries, or their associated reservoirs upstream of the Deta.

Under Alternative 3 LLT, modeling indicates that long-term annual average flows on the San Joaquin River would decrease by 6%, relative to existing conditions, 5% relative to No Action Alternative NT, and would remain virtually the same relative to No Action Alternative LLT. Similar to the No Action Alternative LLT, these decreases in flow would result in possible increase in long-term average bromide concentrations of about 3%, relative to existing conditions, 2% relative to No Action Alternative NT, and less than <1% relative to No Action Alternative LLT. The small increases in lower San Joaquin River bromide levels that could occur under Alternative 3 LLT, relative to existing, No Action Alternative NT, and No Action Alternative LLT conditions would not be expected to adversely affect the MUN beneficial use, or any other beneficial uses, of the lower San Joaquin River.

Delta

Under Alternative 3 LLT, the geographic extent of effects pertaining to long-term average bromide concentrations in the Delta would be similar to that previously described for Alternative 1A LLT, although the magnitude of predicted long-term change and relative frequency of concentration threshold exceedances would be different. Relative to existing conditions, modeled long-term average bromide concentrations would increase at Staten Island, Emmaton, and Barker Slough, while modeled long-term average bromide concentrations would generally decrease at other assessment locations (Appendix 8E, Bromide Table 8-9). Overall effects would be greatest at Barker Slough, where predicted long-term average bromide concentrations would increase from 51 μg/L to 69 μg/L (34% relative increase) for the modeled 16-year hydrologic period and would increase from 54 μg/L to 99 μg/L (85% relative increase) for the modeled drought period. At Barker Slough, the predicted 50 μg/L exceedance frequency would decrease slightly from 49% under existing conditions to 48% under Alternative 3 LLT, but would increase from 55% to 77% during the drought period. At Barker Slough, the predicted 100 μg/L exceedance frequency would increase from 0% under existing conditions to 22% under Alternative 3 LLT, and would increase from 0% to 47% during the drought period. In contrast, increases in bromide at Staten Island would result in a 50 μg/L bromide threshold exceedance increase from 47% under existing conditions to 71% under Alternative 3 LLT (52% to 73% during the modeled drought period). However, unlike Barker Slough, modeling shows that long-term average bromide concentration at Staten Island would exceed the 100 μg/L assessment threshold concentration 1% under existing conditions and 3% under Alternative 3 LLT (0% to 2% during the modeled drought period). The long-term average bromide concentrations would be 60 μg/L (62 μg/L for the modeled drought period) at Staten Island under Alternative 3 LLT. Changes in exceedance frequency of the 50 μg/L and 100 μg/L concentration thresholds, as well as relative change in long-term average concentration, at other assessment locations would be less substantial.

In comparison, Alternative3 LLT relative to the No Action Alternative NT and No Action Alternative LLT would result in predicted increases in long-term average bromide concentrations at all locations with the exception of the Banks and Jones pumping plants. These increases would be of similar magnitude between No Action Alternative NT and No Action Alternative LLT comparisons, and would continue to be greatest at Barker Slough, where long-term average concentrations are predicted to increase by about 40% (about 89% in drought years) relative to No Action Alternative NT, and would increase by about 38% (about 85% in drought years) relative to No Action Alternative LLT (Appendix 8E, Bromide Table 8-9). Increases in long-term average bromide concentrations would be less than 29% at the remaining assessment locations. Due to the relatively small differences between modeled existing conditions and No Action baselines, changes in the frequency with which concentration thresholds of 50 µg/L and 100 µg/L are exceeded are of similar magnitude to the previously described existing condition comparison.

The increase in long-term average bromide concentrations predicted at Barker Slough, principally the relative increase in 100 µg/L exceedance frequency, would result in a substantial change in source water quality for existing drinking water treatment plants drawing water from the North Bay Aqueduct. As discussed for Alternative 1A, drinking water treatment plants obtaining water via the North Bay Aqueduct utilize a variety of conventional and enhanced treatment technologies in order to achieve DBP drinking water criteria. While the implications of such a modeled change in bromide at Barker Slough are difficult to predict, the substantial modeled increases could lead to adverse changes in the formation of disinfection byproducts such that considerable treatment plant upgrades may be necessary in order to achieve equivalent levels of health protection.

The seasonal intakes at Mallard Slough and City of Antioch are infrequently used due to water quality constraints related to sea water intrusion. On a long-term average basis, bromide at these locations is in excess of 3,000 µg/L, but during seasonal periods of high Delta outflow can be <300 µg/L. Use of the seasonal intakes at Mallard Slough and City of Antioch under Alternative 3 LLT would experience a period average increase in bromide during the months when these intakes would most likely be utilized. For those wet and above normal water year types where mass balance modeling would predict water quality typically suitable for diversion, predicted long-term average bromide would increase from 103 µg/L to 149 µg/L (45% increase) at City of Antioch and would increase from 150 µg/L to 201 µg/L (34% increase) at Mallard Slough relative to existing conditions (Appendix 8E, Bromide Figure 2-3). Increases would be similar for No Action Alternative NT and No Action Alternative LLT comparison.The decisions surrounding the use of these seasonal intakes is largely driven by acceptable water quality, and thus have historically been opportunistic. Opportunity to use these intakes would remain, and the predicted increases in bromide concentrations at the City of Antioch and Mallard Slough intake would not be expected to adversely affect MUN beneficial uses, or any other beneficial use, at these locations.

SWP/CVP Export Service Areas

Under Alternative 3 LLT, improvement in long-term average bromide concentrations would occur at the Banks and Jones pumping plants. Long-term average bromide concentrations for the modeled 16-year hydrologic period at these locations would decrease by as much as 31% relative to existing conditions, 25% relative to No Action Alternative NT, and 21% relative to No Action Alternative LLT. Relative change in long-term average bromide concentration would generally be less for the drought period (≤31%), but would still represent considerable improvement (Appendix 8E, Bromide Tables 8-9). As a result, less frequent bromide concentration exceedances of the 50 µg/L and 100 µg/L assessment thresholds would be predicted and an overall improvement in Export Service Areas water quality would be experienced respective to bromide. Commensurate with the decrease in exported bromide, an improvement in lower San Joaquin River bromide would also be observed since bromide in the lower San Joaquin River is principally related to irrigation water deliveries from the Delta. While the magnitude of this expected lower San Joaquin River improvement in bromide is difficult to predict, the relative decrease in overall loading of bromide to the Export Service Areas would likely alleviate or lessen any expected increase in bromide concentrations at Vernalis (see discussion of Upstream of the Delta) as well locations in the Delta receiving a large fraction of San Joaquin River water, such as much of the south Delta.

Similar to the discussion pertaining to the No Action Alternative LLT, maintenance of SWP and CVP facilities under Alternative 3 LLT would not be expected to create new sources of bromide or contribute towards a substantial change in existing sources of bromide in the affected environment. Maintenance activities would not be expected to cause any substantial change in bromide such that MUN beneficial uses, or any other beneficial use, would be adversely affected anywhere in the affected environment.

CEQA Conclusion: Relative to existing conditions, Alternative 3 LLT operation and maintenance would not result in any substantial change in long-term average bromide concentration upstream of the Delta. Furthermore, under Alternative 3 LLT, water exported from the Delta to the SWP/CVP service area would be substantially improved relative to bromide. Bromide is not bioaccumulative, therefore change in long-term average bromide concentrations would not directly cause bioaccumulative problems in aquatic life or humans. Additionally, bromide is not a constituent related to any 303(d) listings. Alternative 3 LLT operation and maintenance activities would not cause substantial long-term degradation to water quality respective to bromide with the exception of water quality at Barker Slough, source of the North Bay Aqueduct. At Barker Slough, modeled long-term annual average concentrations of bromide would increase by 34%, and 85% during the modeled drought period. For the modeled 16-year hydrologic period the frequency of predicted bromide concentrations exceeding 100 µg/L would increase from 0% under existing conditions to 22% under Alternative 3 LLT, while for the modeled drought period, the frequency would increase from 0% to 47%. Substantial changes in long-term average bromide could necessitate changes in treatment plant operation or require treatment plant upgrades in order to maintain DBP compliance. The model predicted change at Barker Slough is substantial and, therefore, would represent a substantially increased risk for adverse effects on existing MUN beneficial uses should treatment upgrades not be undertaken. The impact is considered significant and mitigation is required. Implementation of Mitigation Measure WQ-5 would reduce identified impacts to a less than significant level by relocating the North Bay Aqueduct outside the influence of sea water intrusion.

Mitigation Measure WQ-5: Move the North Bay Aqueduct intake from Barker Slough to the Sacramento River

Please see Mitigation Measure WQ-5 under Impact WQ-5 in the discussion of Alternative 1A.

Impact WQ-6: Effects on bromide concentrations resulting from implementation of CM2–CM22

Conservation components proposed under Alternative 3 LLT would be the same as those proposed under Alternative 1A LLT. As discussed for Alternative 1A LLT, implementation of the CM2-CM22 would not present new or substantially changed sources of bromide to the project area. Some conservation measures may replace or substitute for existing irrigated agriculture in the Delta. This replacement or substitution is not expected to substantially increase or present new sources of bromide. CM2-CM22 would not be expected to cause any substantial change in bromide such that MUN beneficial uses, or any other beneficial use, would be adversely affected anywhere in the affected environment.

CEQA Conclusion: Conservation components proposed under Alternative 3 LLT would be similar to those proposed under Alternative 1A LLT. As such, effects on bromide resulting from the implementation of CM2-CM22 would be similar to that previously discussed for Alternative 1A LLT. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-7: Effects on chloride concentrations resulting from facilities operations and maintenance (CM1)

Upstream of the Delta

Under Alternative 3A LLT there would be no expected change to the sources of chloride in the Sacramento and eastside tributary watersheds. Chloride loading in these watersheds would remain unchanged and resultant changes in flows from altered system-wide operations would have negligible, if any, effects on the concentration of chloride in the rivers and reservoirs of these watersheds. The modeled long-term annual average flows on the lower San Joaquin River at Vernalis would decrease slightly compared to existing conditions and the No Action Alternative NT, and be similar compared to the No Action Alternative LLT. The reduced flow would result in possible increases in long-term average chloride concentrations of about 2%, relative to the existing conditions and No Action Alternative NT conditions, and no change relative to No Action Alternative LLT. Consequently, Alternative 3A LLT would not be expected to cause exceedance of chloride objectives/criteria or substantially degrade water quality with respect to chloride, and thus would not adversely affect any beneficial uses of the Sacramento River, the eastside tributaries, associated reservoirs upstream of the Delta, or the San Joaquin River.

Delta

Relative to existing conditions, Alternative 3A LLT would result in similar or reduced long-term average chloride concentrations for the 16-year period modeled at seven of the assessment locations, and increased concentrations at the North Bay Aqueduct at Barker Slough (up 28%), San Joaquin River at Staten Island (up 19%), Sacramento River at Emmaton (up 15%), and Sacramento River at Mallard Island (up 3%) (Appendix 8G, Chloride Table Cl-13). Additionally, implementation of tidal habitat restoration under conservation measure CM4 would increase the tidal exchange volume in the Delta, and thus may contribute to increased chloride concentrations in the Bay source water as a result of increased salinity intrusion. Consequently, while uncertain, the magnitude of chloride increases may be greater than indicated herein and would affect the western Delta assessment locations the most which are influenced to the greatest extent by the Bay source water. The following outlines the modeled chloride changes relative to the applicable objectives and beneficial uses of Delta waters.

Municipal Beneficial Uses

Relative to the 150 mg/L Bay-Delta WQCP objective for municipal and industrial beneficial uses, the plots of monthly average chloride concentrations at the Contra Costa Canal at Pumping Plant #1 for the separate water year types indicates that the number of months above the objective would remain unchanged or decrease compared to the existing conditions (Appendix 8G, Figure Cl-1). The modeled chloride concentrations at the San Joaquin River at Antioch location would never meet this objective; however, this represents no change from the existing conditions.

Relative to the 250 mg/L objective, an increased frequency of exceedances would occur for the 16-year period modeled at the San Joaquin River at Antioch (i.e., from 66% under existing conditions to 74%) and Sacramento River at Mallard Island (i.e., from 85% under existing conditions to 87%) (Appendix 8G, Table Cl-14), and would cause further degradation at Antioch in March and April (Appendix 8G, Table Cl-15). The frequency of exceedances at the Contra Costa Canal at Pumping Plant #1 would not increase (Appendix 8G, Table Cl-14); however, available assimilative capacity would be reduced by up to 100% (i.e., eliminated) in October and November compared to existing conditions (Appendix 8G, Table Cl-15), reflecting substantial degradation during these months when average concentrations would be near, or exceed, the objective. Based on the additional seasonal exceedances of the municipal objective and magnitude of long-term average water quality degradation with respect to chloride at interior and western Delta locations, the potential exists for substantial adverse effects on the municipal and industrial beneficial uses through reduced opportunity for diversion of water with acceptable salinity.

Aquatic Life Beneficial Uses

Relative to the 230 mg/L chronic EPA aquatic life criterion, monthly average chloride concentrations at the northern and eastern Delta locations would not exceed the criteria and the frequency of exceedances at most interior and southern Delta locations would decrease for the 16-year period modeled (Appendix 8G, Table Cl-14). However, substantial reductions in assimilative capacity would occur compared to existing conditions in August and October at Franks Tract (i.e., up to 100%, or elimination) and in August and September at Old River at Rock Slough (i.e., up to 100%) (Appendix 8G, Table Cl-16) when concentrations would be near, or exceed, the criterion (Appendix 8G, Figure Cl-3), thus indicating the potential for increased frequency of exceedances and adverse effects on aquatic life beneficial uses.

303(d) Listed Water Bodies

With respect to the 303(d) listing for chloride in Tom Paine Slough, the monthly average chloride concentrations for the 16-year period modeled at Old River at Tracy Road would generally be similar compared to existing conditions, and thus, would not be further degraded on a long-term basis (Appendix 8G, Figure Cl-3). With respect to Suisun Marsh, the monthly average chloride concentrations for the 16-year period modeled would increase compared to existing conditions in some months during October through May at the Sacramento River at Collinsville (Appendix 8G, Figure Cl-4), Mallard Island (Appendix 8G, Figure Cl-2), and increase substantially at Montezuma Slough at Beldon's Landing (i.e., up to a tripling of concentration in December through February) (Appendix 8G, Figure Cl-5), thereby contributing to additional, measureable long-term degradation that potentially would adversely affect the necessary actions to reduce chloride loading for any TMDL that is developed.

Relative to the No Action Alternative NT and No Action Alternative LLT conditions, Alternative 3A LLT would result in increased long-term average chloride concentrations for the 16-year period modeled at nine of the assessment locations (Appendix 8G, Table Cl-13). The increases in long-term average chloride concentrations would generally be largest compared to the No Action Alternative NT condition, ranging from 1% at the San Joaquin River at Buckley Cove to 33% at the North Bay Aqueduct at Barker Slough. Long-term average chloride concentrations would decrease at the Banks pumping plant and Jones pumping plant locations. The modeled chloride changes relative to the applicable objectives and potential effects on beneficial uses are as follows.

SWP/CVP Export Service Areas

Under Alternative 3A LLT, long-term average chloride concentrations for the 16-year period modeled at the Banks and Jones pumping plants would decrease by as much as 30% relative to existing conditions, 25% relative to No Action Alternative NT, and 21% compared to No Action Alternative LLT (Appendix 8G, Chloride Table Cl-13). The modeled frequency of exceedances of applicable water quality objectives/criteria would decrease relative to existing conditions, No Action Alternative NT, and No Action Alternative LLT, for both the 16-year period and the drought period modeled (Appendix 8G, Chloride Table Cl-14). Consequently, water exported into the SWP/CVP service area would generally be of similar or better quality with regards to chloride relative to existing conditions and the No Action Alternative NT and No Action Alternative LLT conditions.

Commensurate with the reduced chloride concentrations in water exported to the service area, reduced chloride loading in the lower San Joaquin River would be anticipated which would likely alleviate or lessen any expected increase in chloride at Vernalis related to decreased annual average San Joaquin River flows (see discussion of Upstream of the Delta).

Maintenance of SWP and CVP facilities would not be expected to create new sources of chloride or contribute towards a substantial change in existing sources of chloride in the affected environment. Maintenance activities would not be expected to cause any substantial change in chloride such that any long-term water quality degradation would occur, thus, beneficial uses would not be adversely affected anywhere in the affected environment.

CEQA Conclusion: Chloride is not a bioaccumulative constituent, thus any increased concentrations under Alternative 3A LLT would not result in adverse chloride bioaccumulation effects on aquatic life or humans. Alternative 3A LLT maintenance would not result in any substantial changes in chloride concentration upstream of the Delta or in the SWP/CVP service area. Relative to existing conditions, the Alternative 3A LLT would result in substantially increased chloride concentrations such that frequency of exceedances of the 250 mg/L Bay-Delta WQCP objective would increase at the San Joaquin River at Antioch (by 8%) and at Mallard Slough (by 2%), and long-term degradation may occur at Antioch, Mallard Slough, and Contra Costa Canal at Pumping Plant #1, that may result in adverse effects on the municipal and industrial water supply beneficial use. Relative to the existing conditions, long-term degradation at interior Delta locations also may increase the risk of exceeding aquatic life criteria. Relative to the existing conditions, the modeled increased chloride concentrations and degradation in the western Delta could further contribute, at measurable levels (i.e., over a tripling of concentration), to the existing 303(d) listed impairment due to chloride in Suisun Marsh for the protection of fish and wildlife. Based on these findings, this impact is determined to be potentially significant due to increased chloride concentrations and degradation at western and interior Delta locations and its effects on municipal and industrial water supply and fish and wildlife beneficial uses.

While implementation of Mitigation Measure WQ-7 may reduce this impact, the feasibility and effectiveness of this mitigation measures is uncertain. Therefore, the available mitigation would not necessarily reduce the impact to a level that would be less than significant.

Mitigation Measure WQ-7: Conduct additional evaluation and modeling of increased chloride levels and develop and implement phased actions to reduce levels

Please see Mitigation Measure WQ-5 under Impact WQ-5 in the discussion of Alternative 1A.

Mitigation Measure WQ-7e: In addition to the actions identified in Mitigation Measure WQ-7, to mitigate for adverse effects on municipal and industrial water supply and fish and wildlife beneficial uses, the following phased actions would reduce the potential adverse effects on aquatic life beneficial uses at interior Delta locations. DWR and Reclamation shall coordinate with the State Water Board and DFG to determine whether the predicted increased chloride concentrations would actually result in unacceptable adverse effects on Delta species, which in part would require whether there are specific water quality and biotic characteristics in the Delta that warrant modification of the default USEPA chronic and chloride criteria for acute aquatic protection. USEPA's current National Recommended Water Quality Criteria for chloride, upon which the predicted chloride concentrations were compared for this impact assessment, were published in 1988. The State of Iowa Department of Natural Resources recently performed a criteria recalculation process, with assistance from USEPA, and determined that the 1988 USEPA criteria development process included erroneous data (Iowa Department of Natural Resources 2009). Additionally, Iowa and USEPA determined that the appropriate chloride criteria are dependent on total hardness and sulfate content of the receiving water, which are water quality factors not considered in the 1988 USEPA criteria. Consequently, this phased mitigation action would involve work to conduct receiving-water studies to determine the appropriate chloride criteria applicable to Delta waters. Upon development and verification of the appropriate chloride criteria, DWR and Reclamation would reevaluate the effects of increased chloride concentrations to aquatic life, and implement the other phased actions of Mitigation Measure WQ-8 to the extent feasible to reduce or avoid the adverse effects.

Impact WQ-8: Effects on chloride concentrations resulting from implementation of CM2–CM22

Under Alternative 3A LLT, the types and geographic extent of effects on chloride concentrations in the Delta as a result of implementation of the other conservation measures (i.e., CM2–CM22) would be similar to, and undistinguishable from, those effects previously described for Alternative 1A LLT. The conservation measures would present no new direct sources of chloride to the affected environment. Moreover, some habitat restoration conservation measures (CM4–CM10) would occur on lands within the Delta currently used for irrigated agriculture, thus replacing agricultural land uses with restored tidal wetlands, floodplain, and related channel margin and off-channel habitats. The potential reduction in irrigated lands within the Delta may result in reduced discharges of agricultural field drainage with elevated chloride concentrations, which would be considered an improvement compared to existing conditions.

***CEQA Conclusion*:** Implementation of the CM2–CM22 for Alternative 3A LLT would not present new or substantially changed sources of chloride to the affected environment upstream of the Delta, within Delta, or in the SWP/CVP service area. Replacement of irrigated agricultural land uses in the Delta with habitat restoration conservation measures may result in some reduction in discharge of agricultural field drainage with elevated chloride concentrations, thus resulting in improved water quality conditions. Based on these findings, this impact is considered to be less than significant. No mitigation is required.

Impact WQ-9: Effects on dissolved oxygen resulting from facilities operations and maintenance (CM1)

Effects of CM1 on DO under Alternative 3 are the same as those discussed for Alternative 1A LLT. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-10: Effects on dissolved oxygen resulting from implementation of CM2-CM22

Effects of CM2–23 on DO under Alternative 3 are the same as those discussed for Alternative 1A LLT. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-11: Effects on electrical conductivity concentrations resulting from facilities operations and maintenance (CM1)

Upstream of the Delta

For the same reasons stated for the No Action Alternative LLT, EC levels (highs, lows, typical conditions) in the Sacramento River and its tributaries, the eastside tributaries, their associated reservoirs, and the San Joaquin River upstream of the Delta under Alternative 3 LLT are not expected to be outside the ranges occurring under existing conditions or would occur under the No Action Alternative NT and LLT. Any minor changes in EC levels that could occur under Alternative 3 LLT in water bodies upstream of the Delta would not be of sufficient magnitude, frequency and geographic extent that would cause adverse effects on beneficial uses or substantially degrade water quality with regard to EC.

Delta

Relative to existing conditions, Alternative 3 LLT would result in a fewer number of days when Bay-Delta WQCP compliance locations in the western, interior, and southern Delta would exceed EC objectives or be out of compliance with the EC objectives, with the exception of the San Joaquin River at San Andreas Landing in the interior Delta (Appendix H, Table EC-3). The percent of days the San Andreas Landing EC objective would be exceeded for the entire period modeled (1976-1991) would increase from 1% under existing conditions to 2% under Alternative 3 LLT. Further, the percent of days out of compliance with the EC objective would increase from 1% under existing conditions to 4% under Alternative 3 LLT. Average EC levels at the western and southern Delta compliance locations would decrease from 1-28% for the entire period modeled and 2-30% during the drought period modeled (1987-1991) (Appendix H, Table EC-14). At the two interior Delta locations, there would be increases in average EC: the S. Fork Mokelumne River at Terminous average EC would increase 4% for the entire period modeled and 3% during the drought period modeled; and San Joaquin River at San Andreas Landing average EC would increase 12% for the entire period modeled and 13% during the drought period modeled. On average, EC would increase at San Andreas Landing during all months except November. Average EC in the S. Fork Mokelumne River at Terminous would increase during all months (Appendix H, Table EC-14). Of the Clean Water Act section 303(d) listed sections of the Delta – western, northwestern, and southern – none of these portions of the Delta would have an increased frequency of exceedance of EC objectives (Appendix H, Table EC-1). Thus, Alternative 3 LLT is not expected to contribute to additional impairment and adversely affect beneficial uses for section 303(d) listed Delta waterways, relative to existing conditions. These EC changes are similar to that described for Alternative 1A LLT.

Relative to the No Action Alternative NT, the change in percent compliance with Bay-Delta WQCP EC objectives under Alternative 3 LLT would be similar to that described above relative to existing conditions. The exception is that there would also be a slight increase (1% or less) in the percent of days the EC objective would be exceeded in the San Joaquin River at Vernalis and Brandt Bridge, and in Old River near Middle River, located in the southern Delta, for the entire period modeled. For the entire period modeled, average EC levels would increase at all Delta compliance locations relative to the No Action Alternative NT, except in Three Mile Slough near the Sacramento River. The greatest average EC increase would occur in the San Joaquin River at San Andreas Landing (23%); the increase at the other locations would be 2-8% (Appendix H, Table EC-14). During the drought period modeled, average EC would increase at all locations, except Three Mile Slough and San Joaquin River at Jersey Point. The greatest average EC increase during the drought period modeled would occur in the San Joaquin River at San Andreas Landing (22%); the increase at the other locations would be 1-6% (Appendix H, Table EC-14). Given that the southern Delta is Clean Water Act section 303(d) listed as impaired due to elevated EC, the increase in the incidence of exceedance of EC objectives and increases in long-term and drought period average EC at the southern Delta locations under Alternative 3 LLT, relative to the No Action Alternative NT, has the potential to contribute to additional impairment and potentially adversely affect beneficial uses. These EC changes are similar to that described for Alternative 1A LLT.

Relative to the No Action Alternative LLT, the locations with an increased frequency of exceedance of the Bay-Delta WQCP EC objectives under Alternative 3 LLT would differ from that described relative to the No Action Alternative NT (Appendix H, Table EC-3). The percent of days exceeding EC objectives and percent of days out of compliance would increase at: San Joaquin River at Jersey Point, San Andreas Landing, and Prisoners Point; and Old River near Middle River; and Old River at Tracy Bridge. The increase in percent of days exceeding the EC objective would be 1% or less and the increase in percent of days out of compliance would be 3% or less. Average EC would increase at some compliance locations for the entire period modeled: San Joaquin River at Jersey Point (2%), S. Fork Mokelumne River at Terminous (4%),San Joaquin River at San Andreas Landing (18%), and San Joaquin River at Prisoners Point (9%) (Appendix H, Table EC-14). For the drought period modeled, the locations with an average EC increase, relative to the No Action Alternative LLT, would be: S. Fork Mokelumne River at Terminous (4%), San Joaquin River at San Andreas Landing (13%), San Joaquin River at Brandt Bridge (1%), Old River at Tracy Bridge (1%), and San Joaquin River at Prisoners Point (5%) (Appendix H, Table EC-14). Given that the western and southern Delta is Clean Water Act section 303(d) listed as impaired due to elevated EC, the increase in the incidence of exceedance of EC objectives and increases in long-term and drought period average EC at the western and southern Delta locations under Alternative 1A LLT, relative to the No Action Alternative LLT, has the potential to contribute to additional impairment and potentially adversely affect beneficial uses. These EC changes are similar to that described for Alternative 1A LLT.

For Suisun Marsh, October-May is the period when Bay-Delta WQCP EC objectives for protection of fish and wildlife apply. Long-term average EC would increase under Alternative 3 LLT, relative to existing conditions, during the months of March through May by 0.3-0.9 mS/cm in the Sacramento River at Collinsville (Appendix H, Table EC-21). Long-term average EC would decrease relative to existing conditions in Montezuma Slough at National Steel during October-May (Appendix H, Table

EC-22). The most substantial increase would occur near Beldon Landing, with long-term average EC levels increasing by 1.8-6.1 mS/cm, depending on the month, which would be a doubling or tripling of long-term average EC relative to existing conditions (Appendix H, Table EC-23). Sunrise Duck Club and Volanti Slough also would have long-term average EC increases during all months of 1.7-4.0 mS/cm (Appendix H, Tables EC-24 and EC-25). The degree to which the long-term average EC increases would cause exceedance of Bay-Delta WQCP objectives is unknown, because objectives are expressed as a monthly average of daily high tide EC, which does not have to be met if it can be demonstrated "equivalent or better protection will be provided at the location" (State Water Resources Control Board 2006:14). The described long-term average EC increase may, or may not, contribute to adverse effects on beneficial uses, depending on how and when wetlands are flooded, soil leaching cycles, and how recirculation of water is managed, and future actions taken with respect to the marsh. However, the EC increases at certain locations would be substantial and it is uncertain the degree to which current management plans for the Suisun Marsh would be able to address these substantially higher EC levels and protect beneficial uses. Thus, these increased EC levels in Suisun Marsh are considered to have a potentially adverse effect on marsh beneficial uses. Long-term average EC increases in Suisun Marsh under Alternative 3 LLT relative to the No Action Alternative NT and LLT would be similar to the increases relative to existing conditions. These EC changes are similar to that described for Alternative 1A LLT.

None of the compliance locations in the western, northwestern, and southern portions of the Delta – which are the Clean Water Act section 303(d) listed regions of the Delta – would have an increased frequency of exceedance of the Bay-Delta WQCP objectives (Appendix H, Table EC-3) and long-term average EC levels at compliance locations in these regions would decrease relative to existing conditions (Appendix H, Table EC-14). Thus, Alternative 3 LLT is not expected to contribute to additional impairment and potentially adversely affect beneficial uses for section 303(d) listed Delta waterways. Suisun Marsh also is section 303(d) listed as impaired due to elevated EC, and the potential increases in long-term average EC concentrations could contribute to additional impairment, because the increases would be double or triple that relative to existing conditions and the No Action Alternative NT and LLT.

SWP/CVP Export Service Areas

At the Banks and Jones pumping plants, Alternative 3 LLT would result in no exceedances of the Bay-Delta WQCP's 1,000 μmhos/cm EC objective for the entire period modeled (Appendix H, Table EC-10). Thus, there would be no adverse effect to the beneficial uses in the SWP/CVP Export Service Areas using water pumped at this location under the Alternative 3 LLT.

At the Banks pumping plant, relative to existing conditions, average EC levels under Alternative 3 LLT would decrease 18% for the entire period modeled and 18% during the drought period modeled. Relative to the No Action Alternative NT, average EC levels would decrease by 12% for the entire period modeled and 11% during the drought period modeled. Similar decreases in EC would occur relative to the No Action Alternative LLT. (Appendix H, Table EC-14)

At the Jones pumping plant, relative to existing conditions, average EC levels under Alternative 3 LLT would decrease 17% for the entire period modeled and 20% during the drought period modeled. Relative to the No Action Alternative NT, average EC levels would decrease by 11% for the entire period modeled and 14% during the drought period modeled. Similar decreases in average EC would occur relative to the No Action Alternative LLT. (Appendix H, Table EC-14)

Based on the decreases in long-term average EC levels that would occur at the Banks and Jones pumping plants, Alternative 3 LLT would not cause degradation of water quality with respect to EC in the SWP/CVP Export Service Areas; rather, Alternative 3 LLT would improve long-term average EC conditions in the SWP/CVP Export Service Areas.

Commensurate with the EC decrease in exported waters, an improvement in lower San Joaquin River average EC levels would be expected since EC in the lower San Joaquin River is, in part, related to irrigation water deliveries from the Delta. While the magnitude of this expected lower San Joaquin River improvement in EC is difficult to predict, the relative decrease in overall loading of EC-elevating constituents to the Export Service Areas would likely alleviate or lessen any expected increase in EC at Vernalis related to decreased annual average San Joaquin River flows (see EC impact discussion under No Action Alternative LLT).

The export area of the Delta is listed on the state's CWA Section 303(d) list as impaired due to elevated EC. Alternative 3 LLT would result in lower average EC levels relative to existing conditions and the No Action Alternative NT and LLT and, thus, would not contribute to additional beneficial use impairment related to elevated EC in the SWP/CVP Export Service Areas waters.

CEQA Conclusion: Relative to existing conditions, Alternative 3 LLT would not result in any substantial increases in long-term average EC levels upstream of the Delta or in the SWP/CVP Export Service Areas. In the Plan Area, Alternative 3 LLT would result in an increase of 1% in the frequency with which Bay-Delta WQCP EC objectives for agricultural beneficial use protection are exceeded in the San Joaquin River at San Andreas Landing (interior Delta) for the entire period modeled (1976-1991). Further, average EC levels at San Andreas Landing would increase by 12% for the entire period modeled and 13% during the drought period modeled. Because EC is not bioaccumulative, the increases in long-term average EC levels would not directly cause bioaccumulative problems in aquatic life or humans. The interior Delta is not Clean Water Act section 303(d) listed for elevated EC, and other portions of the Delta that are section 303(d) listed would not have increased long-term average EC levels. The increases in long-term and drought period average EC levels and increased frequency of exceedance of EC objectives that would occur in the San Joaquin River at San Andreas Landing would potentially contribute to adverse effects on the agricultural beneficial uses in the interior Delta. This impact is considered to be potentially significant.

Further, relative to existing conditions, Alternative 3 LLT would result in substantial increases in long-term average EC during the months of October through May in Suisun Marsh, such that EC levels would be double or triple that occurring under existing conditions. The increases in long-term average EC levels that would occur in Suisun Marsh could further degrade existing EC levels and thus contribute additionally to adverse effects on the fish and wildlife beneficial uses. Because EC is not bioaccumulative, the increases in long-term average EC levels would not directly cause bioaccumulative problems in wildlife. Suisun Marsh is Clean Water Act section 303(d) listed for elevated EC and the increases in long-term average EC that would occur in the marsh could make beneficial use impairment measurably worse. This impact is considered to be potentially significant.

While Mitigation Measure WQ-11 may reduce these impacts, the feasibility and effectiveness of this mitigation measures is uncertain. Therefore, the available mitigation would not necessarily reduce the impact to a level that would be less than significant.

Mitigation Measure WQ-11: Reduce, avoid, and compensate for reduced water quality conditions

Please see Mitigation Measure WQ-11 under Impact WQ-11 in the discussion of Alternative 1A.

Impact WQ-12: Effects on electrical conductivity resulting from implementation of CM2–CM22

Effects of CM2–CM22 on EC under Alternative 3 LLT are the same as those discussed for Alternative 1A LLT. There would be no adverse effect. Under CEQA, this impact is considered to be less than significant. No mitigation is required.

Impact WQ-13: Effects on mercury concentrations resulting from facilities operations and maintenance (CM1)

[*Note to Lead Agencies: This assessment is in preparation*].

Impact WQ-14: Effects on mercury concentrations resulting from implementation of CM2–23

[*Note to Lead Agencies: This assessment is in preparation*].

Impact WQ-15: Effects on nitrate concentrations resulting from facilities operations and maintenance (CM1)

Upstream of the Delta

For the same reasons stated for the No Action Alternative LLT, Alternative 3 LLT would have negligible, if any, impact on nitrate concentrations in the rivers and reservoirs upstream of the Delta in the Sacramento River watershed relative to existing conditions and the No Action Alternative NT and LLT.

Under Alternative 3 LLT, modeling indicates that long-term annual average flows on the San Joaquin River would decrease by an estimated 6%, relative to existing conditions, 5% relative to No Action NT, and would remain virtually the same relative to No Action LLT (crossreference to Modeling Data Appendix, CALSIM Flow Data for Vernalis). Given these relatively small decreases in flows and the weak correlation between nitrate and flows in the San Joaquin River (see Nitrate Appendix J Figure 2), it is expected that nitrate concentrations in the San Joaquin River will be minimally affected, if at all, by changes in flow rates under Alternative 3 LLT.

Any negligible changes in nitrate-N concentrations that may occur in the water bodies of the affected environment located upstream of the Delta would not be of frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the quality of these water bodies, with regards to nitrate.

Delta

Results of the mixing calculations indicate that under Alternative 3 LLT, relative to existing conditions, No Action NT, and No Action LLT, nitrate concentrations throughout the Delta are anticipated to remain low (<1.4 mg/L-N) relative to adopted objectives (Nitrate Appendix J Table 13 and 14). Although changes at specific Delta locations and for specific months may be substantial on a relative basis, the absolute concentration of nitrate in Delta waters would remain low (<1.4 mg/L-N) in relation to the drinking water MCL of 10 mg/L-N, as well as all other thresholds identified in

Table XX. Long-term average nitrate concentrations are anticipated to remain below 1 mg/L-N at all 11 assessment locations except the San Joaquin River at Buckley Cove, where long-term average concentrations would be somewhat above 1 mg/L-N. Nevertheless, at this location, long-term average nitrate concentration would be somewhat reduced under Alternative 3 LLT, relative to existing conditions and the No Action NT, and would be nearly the same (i.e., any increase would be negligible) as that under the No Action LLT. No additional exceedances of the MCL are anticipated at any location (Nitrate Appendix J Table 13). On a monthly average basis and on a long term annual average basis, for all modeled years and for the drought period (1987-1991) only, use of assimilative capacity available under existing conditions, No Action NT, and No Action LLT, relative to the drinking water MCL of 10 mg/L-N, was low or negligible (i.e., <5%) for all locations and months, except for Jones PP in November, where use of assimilative capacity available under existing conditions and No Action NT were 6.5% and 5%, respectively, in the drought period (1987-1991) (Nitrate Appendix J Table 15).

Nitrate concentrations will likely be higher than the modeling results indicate in certain locations, including: (1) in the Sacramento River between Freeport and Mallard Island and other areas in the Delta downstream of Freeport that are influenced by Sacramento River water, the increase becoming greater with increasing distance downstream, due to conversion of ammonia from the SRWTP discharge at Freeport (under existing conditions and No Action Alternative NT only, since upgrades to SRWTP that substantially reduce ammonia concentrations in the Sacramento River downstream of Freeport are assumed in the LLT; see the Ammonia section of this chapter for further discussion); (2) immediately downstream of wastewater treatment plants that practice nitrification, but not denitrification (e.g., City of Rio Vista Beach WWTF, Town of Discovery Bay WWTF, City of Stockton RWCF).

The effect of (1) (above) is expected to be small, on the order of 1 mg/L nitrate as N or less in the existing conditions and No Action Alternative NT. This is because the existing increase appears to be from approximately 0.1 mg/L-N to approximately 0.4-0.5 mg/L-N over this reach, due to approximately a 1:1 conversion of ammonia-N to nitrate-N (CVWQCB 2010:32). Because this nitrate is assumed not to be generated under Alternative 3 LLT, average concentrations would be expected to decrease under Alternative 3 LLT in this reach of the Sacramento River relative to existing conditions and the No Action Alternative NT. Regarding number (2) (above), for all such facilities in the Delta, the Regional Water Boards have issued NPDES permits that allow discharge of wastewater containing nitrate into the Delta, and under these permits, the State has determined that no beneficial uses are adversely affected by the discharge, and that the discharger's use of available assimilative capacity of the water body is acceptable. When dilution is necessary in order for the discharge to be in compliance with the Basin Plans (which incorporate the 10 mg/L-N MCL by reference), not all of the assimilative capacity of the receiving water is granted to the discharger. Thus, limited decreases in flows are not anticipated to result in systemic exceedances of the MCLs by these POTWs. Furthermore, NPDES permits are renewed on a 5-year basis, and thus, if under changes in flows, dilution was no longer sufficient to maintain nitrate below the MCL in the receiving water, the NPDES permit renewal process would address such cases.

Therefore, any increases in nitrate-N concentrations that may occur at certain locations within the Delta would not be of frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the water quality at these locations, with regards to nitrate.

SWP/CVP Export Service Areas

Assessment of effects of nitrate in the SWP and CVP Export Service Areas is based on effects on nitrate-N at the Banks and Jones pumping plants.

Results of the mixing calculations indicate that under Alternative 3 LLT, relative to existing conditions, No Action NT, and No Action LLT, nitrate concentrations at Banks and Jones pumping plants are anticipated to decrease on a long-term average annual basis (Nitrate Appendix J Table 13 and 14). During the late summer, particularly in the drought period assessed, concentrations are expected to increase substantially on a relative basis (i.e., >50%), but the absolute value of these changes (i.e., in mg/L-N) is small. Additionally, given the many factors that contribute to potential algal blooms in the SWP and CVP canals within the Export Service Area, and the lack of studies that have shown a direct relationship between nutrient concentrations in the canals and reservoirs and problematic algal blooms in these water bodies, there is no basis to conclude that these small (i.e., generally <0.3 mg/L-N), seasonal increases in nitrate concentrations would increase the potential for problem algal blooms in the SWP and CVP Export Service Area. No additional exceedances of the MCL are anticipated (Nitrate Appendix J Table 13). On a monthly average basis and on a long term annual average basis, for all modeled years and for the drought period (1987–1991) only, use of assimilative capacity available under existing conditions and No Action NT, relative to the 10 mg/L-N MCL, was negligible for both Banks and Jones pumping plants (Nitrate Appendix J Table 15).

Any increases in nitrate-N concentrations that may occur in water exported via Banks and Jones pumping plants are not expected to result in an adverse effects to beneficial uses or substantially degrade the quality of exported water, with regards to nitrate.

CEQA Conclusion: There would be no substantial, long-term increase in nitrate-N concentrations in the rivers and reservoirs upstream of the Delta, in the Delta Region, or the waters exported to the CVP and SWP service areas under Alternative 3 LLT relative to existing conditions. As such, this alternative is not expected to cause additional exceedance of applicable water quality objectives/criteria by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. Because nitrate concentrations are not expected to increase substantially, no long-term water quality degradation is expected to occur and, thus, no adverse effects to beneficial uses would occur. Nitrate is not 303(d) listed within the affected environment and thus any increases than may occur in some areas and months would not make any existing nitrate-related impairment measurably worse because no such impairments currently exist. Because nitrate is not bioaccumulative, increases that may occur in some areas and months would not bioaccumulate to greater levels in aquatic organisms that would, in turn, pose substantial health risks to fish, wildlife, or humans. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-16: Effects on nitrate concentrations resulting from implementation of CM2–23

Effects of CM2–23 on nitrate under Alternative 3 LLT are the same as those discussed for Alternative 1A LLT. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-17: Effects on dissolved organic carbon concentrations resulting from facilities operations and maintenance (CM1)

Upstream of the Delta

Under Alternative 3 LLT, there would be no substantial change to the sources of DOC within the watersheds upstream of the Delta. Moreover, long-term average flow and DOC levels in the Sacramento River at Hood and San Joaquin River at Vernalis are poorly correlated. Thus changes in system operations and resulting reservoir storage levels and river flows would not be expected to cause a substantial long-term change in DOC concentrations in the water bodies upstream of the Delta. Any negligible changes in DOC levels in water bodies upstream of the Delta under Alternative 3 LLT, relative to existing conditions and the No Action Alternative NT and LLT, would not be of sufficient frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the quality of these water bodies, with regards to DOC.

Delta

Under Alternative 3 LLT, the geographic extent of effects pertaining to long-term average DOC concentrations in the Delta would be similar to that previously described for Alternative 1A LLT, although the magnitude of predicted long-term change and relative frequency of concentration threshold exceedances would be less. Modeled effects would be greatest at Franks Tract, Rock Slough, and Contra Costa PP No. 1., where for the 16-year hydrologic period and the modeled drought period, long-term average concentration increases ranging from 0.2-0.3 mg/L would be predicted (≤8% net increase) (Appendix 8K, DOC Table 4). Increases in long-term average concentrations would correspond to more frequent concentration threshold exceedances, with the greatest change occurring at Rock Slough and Contra Costa PP No. 1 locations. For Rock Slough, long-term average DOC concentrations exceeding 3 mg/L would increase from 52% under existing conditions to 65% under the Alternative 3 LLT (an increase from 47% to 63% for the drought period), and concentrations exceeding 4 mg/L would increase from 30% to 33% (32% to 38% for the drought period). For Contra Costa PP No. 1, long-term average DOC concentrations exceeding 3 mg/L would increase from 52% under existing conditions to 65% under Alternative 3 LLT 45% to 67% for the drought period), and concentrations exceeding 4 mg/L would increase from 32% to 37% (35% to 42% for the drought period). Relative change in frequency of threshold exceedance for other assessment locations would be similar or less. While Alternative 3 LLT would generally lead to slightly higher long-term average DOC concentrations (≤0.3 mg/L) at some municipal water intakes and Delta interior locations, the predicted change would not be expected to adversely affect MUN beneficial uses, or any other beneficial use.

In comparison, Alternative 3 LLT relative to the No Action Alternative NT and No Action Alternative LLT would generally result in a similar magnitude of change to that discussed for the comparison to existing conditions. Maximum increases of 0.2- 0.3 mg/L DOC (i.e., ≤8%) would be predicted at Franks Tract, Rock Slough, and Contra Costa PP No. 1 relative to No Action Alternative NT, while maximum increases at these locations would be slightly less (i.e., between 0.1-0.2 mg/L) when compared to No Action Alternative LLT (Appendix 8K, DOC Table 4). Threshold concentration exceedance frequency trends would also be similar to that discussed for the existing condition comparison, with exception to the predicted 4 mg/L exceedance frequency at Buckley Cove. In comparison to the No Action Alternative NT, the frequency which long-term average DOC concentrations exceeded 4 mg/L at Buckley Cove would increase from 23% to 33% (37% to 63% for the modeled drought period), with slightly smaller increases when comparing to No Action

Alternative LLT. While the Alternative 3 LLT would generally lead to slightly higher long-term average DOC concentrations at some Delta assessment locations when compared to No Action Alternative NT and No Action Alternative LLT conditions, the predicted change would not be expected to adversely affect MUN beneficial uses, or any other beneficial use, particularly when considering the relatively small change in long-term annual average concentration.

As discussed for Alternative 1A, substantial change in ambient DOC concentrations would need to occur before significant changes in drinking water treatment plant design or operations are triggered. The increases in long-term average DOC concentrations estimated to occur at various Delta locations under Alternative 3 are of sufficiently small magnitude that they will not require existing drinking water treatment plants to substantially upgrade treatment for DOC removal above levels currently employed.

Relative to existing, No Action Alternative NT, and No Action Alternative LLT conditions, Alternative 3 LLT would lead to predicted improvements in long-term average DOC concentrations at Barker Slough, Banks and Jones pumping plants. At these locations, long-term average DOC concentrations would be predicted to decrease by as much as <0.1 - 0.4 mg/L, depending on baseline comparison.

SWP/CVP Export Service Areas

Under Alternative 3 LLT, modeled long-term average DOC concentrations would decrease at Banks and Jones pumping plants for both the modeled 16-year hydrologic period and the modeled drought period, relative to existing conditions, No Action Alternative NT, and No Action Alternative LLT. Relative to existing conditions, long-term average DOC concentrations at Banks would be predicted to decrease by 0.3 mg/L (0.1 mg/L during drought period) (Appendix 8K, DOC Tables 4). At Jones, long-term average DOC concentrations would be predicted to decrease by 0.2 mg/L (<0.1 mg/L during drought period). Such decreases in long-term average DOC, however, would not necessarily translate into lower exceedance frequencies for concentration thresholds. To the contrary, long-term average DOC concentrations at Banks exceeding 3 mg/L would increase from 64% under existing conditions to 69% under Alternative 3 LLT (57% to 92% for the drought period), and at Jones would increase from 71% to 77% (72% to 88% for the drought period). In contrast, however, the frequency of concentrations exceeding 4 mg/L at Banks and Jones would decrease or remain relatively unchanged. Comparisons to No Action Alternative NT and No Action Alternative LLT yield similar trends, but with slightly smaller 16-year hydrologic period and drought period changes. Overall, modeling results for the SWP/CVP Export Service Areas predict an overall long-term improvement in Export Service Areas water quality, primarily through a reduction in exports of water exceeding 4 mg/L.

Similar to the discussion pertaining to the No Action Alternative LLT, maintenance of SWP and CVP facilities under Alternative 3 LLT would not be expected to create new sources of DOC or contribute towards a substantial change in existing sources of DOC in the affected area. Maintenance activities would not be expected to cause any substantial change in long-term average DOC concentrations such that MUN beneficial uses, or any other beneficial use, would be adversely affected.

***CEQA Conclusion*:** Relative to existing conditions, Alternative 3 LLT operation and maintenance would not result in any substantial change in long-term average DOC concentration upstream of the Delta or result in substantial increase in the frequency with which long-term average DOC concentrations exceeds 2, 3, or 4 mg/L levels at the 11 assessment locations analyzed for the Delta. Modeled long-term average DOC concentrations would increase by no more than 0.3 mg/L at any single Delta assessment location (i.e., ≤8% relative increase), with long-term average concentrations estimated to remain at or below 4.0 mg/L at all Delta locations assessed, with the exception of Buckley Cove on the San Joaquin River during the drought period modeled. Nevertheless, long-term average concentrations at Buckley Cove are predicted to remain the same during the drought period, relative to existing conditions. The increases in long-term average DOC concentration that could occur within the Delta would not be of sufficient magnitude to adversely affect the MUN beneficial use, or any other beneficial uses, of Delta waters or waters of the SWP/CVP Service Area. Because DOC is not bioaccumulative, the increases in long-term average DOC concentrations would not directly cause bioaccumulative problems in aquatic life or humans. Finally, DOC is not causing beneficial use impairments and thus is not 303(d) listed for any water body within the affected environment. Thus, the increases in long-term average DOC that could occur at various locations would not make any beneficial use impairment measurably worse. Because long-term average DOC concentrations are not expected to increase substantially, no long-term water quality degradation with respect to DOC is expected to occur and, thus, no adverse effects on beneficial uses would occur. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-18: Effects on dissolved organic carbon concentrations resulting from implementation of CM2–CM22

Conservation components proposed under Alternative 3 would be the same as those proposed under Alternative 1A. As such, effects on DOC resulting from the implementation of CM2-CM22 would be similar to that previously discussed for Alternative 1A LLT. In summary, conservation measures CM4-CM7 and CM10 could contribute substantial amounts of DOC to raw drinking water supplies, largely depending on final design and operational criteria for the related wetland and riparian habitat restoration activities. Substantially increased long-term average DOC in raw water supplies could lead to a need for treatment plant upgrades in order to appropriately manage DBP formation in treated drinking water. This potential for future DOC increases would lead to substantially greater associated risk of long-term adverse effects on the MUN beneficial use.

CEQA Conclusion: Effects of CM4-CM7 and CM10 on DOC under Alternative 3 LLT would be similar to those discussed for Alternative 1A LLT. Similar to the discussion for Alternative 1A, this impact is considered to be significant and mitigation is required. It is uncertain whether implementation of Mitigation Measure WQ-18 would reduce identified impacts to a less than significant level. Hence, this impact could remain significant after mitigation.

Mitigation Measure WQ-18: Design wetland and riparian habitat features to minimize effects on municipal intakes

Please see Mitigation Measure WQ-18 under Impact WQ-18 in the discussion of Alternative 1A.

Impact WQ- 19: Effects on pathogens resulting from facilities operations and maintenance

Effects of CM1 on pathogens under Alternative 3 are the same as those discussed for Alternative 1A LLT. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-20: Effects on pathogens resulting from implementation of CM2–CM22

Effects of CM2–CM22on pathogens under Alternative 3 are the same as those discussed for Alternative 1A LLT. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-21: Effects on pesticide concentrations resulting from facilities operations and maintenance (CM1)

Upstream of the Delta

For the same reasons stated for the No Action Alternative LLT, under Alternative 3 LLT, no specific operations or maintenance activity of the SWP or CVP would substantially drive a change in pesticide use, and thus pesticide sources would remain unaffected upstream of the Delta. Nevertheless, changes in the timing and magnitude of reservoir releases could have an effect on available dilution capacity along river segments such as the Sacramento, Feather, American, and San Joaquin Rivers.

Under Alternative 3 LLT, winter (November –March) and summer (April – October) season average flow rates on the Sacramento River at Freeport, American River at Nimbus, Feather River at Thermalito and the San Joaquin River at Vernalis would change. Relative to existing condition, No Action Alternative NT and No Action Alternative LLT, seasonal average flow rates on the Sacramento would decrease no more than 9% during the summer and 2% during the winter relative to existing conditions (Appendix 8L, Seasonal average flows Table 1-4). On the Feather River, average flow rates would decrease no more than 14% during the summer, but would increase by as much as 26% in the winter. Similarly, American River average flow rates would decrease by as much as 16% in the summer but would increase by as much as 9% in the winter. Seasonal average flow rates on the San Joaquin River would decrease by as much as 12% in the summer, but increase by as much as 3% in the winter. For the same reasons stated for the No Action Alternative LLT, decreased seasonal average flow of ≤16% is not considered to be of sufficient magnitude to substantially increase pesticide concentrations or alter the long-term risk of pesticide-related toxicity to aquatic life, nor adversely affect other beneficial uses of water bodies upstream of the Delta.

Delta

Sources of diuron, OP and pyrethroid insecticides to the Plan Area include direct input of surface runoff from in-Delta agriculture and Delta urbanized areas as well inputs from rivers upstream of the Delta. Similar to Upstream of the Delta, CVP/SWP operations would not affect these sources.

Under Alternative 3 LLT, the distribution and mixing of Delta source waters would change. Percent change in monthly average source water fraction were evaluated for the modeled 16-year (1976-1991) hydrologic period and a representative drought period (1987-1991), with special attention given to changes in San Joaquin River, Sacramento River and Delta Agriculture sources water fractions. Relative to existing conditions, under Alternative 3 LLT modeled San Joaquin River fractions would increase greater than 10% at (not including Banks and Jones, discussed below) Rock Slough and Contra Costa PP No. 1 (Appendix 8D, Source Water Fingerprinting). At Rock Slough, San Joaquin River source water fractions when modeled for the 16-year hydrologic period would increase 11% during March, while at Contra Costa PP No. 1 San Joaquin River source water fractions when modeled for the 16-year hydrologic period would increase 14% during March. Corresponding increases for the modeled drought period would not be greater than 7% at Rock Slough or Contra Costa PP No. 1. Relative to existing conditions, there would be no modeled increases in Sacramento River fractions greater than 10% (with exception to Banks and Jones which are discussed below) and Delta agricultural fractions greater than 7%. These modeled changes in the source water fractions of Sacramento, San Joaquin and Delta agriculture water are not of sufficient magnitude to substantially alter the long-term risk of pesticide-related toxicity to aquatic life, nor adversely affect other beneficial uses of the Delta.

When compared to No Action Alternative NT and No Action Alternative LLT, changes in source water fractions would be similar in season, geographic extent, and magnitude to those discussed for existing conditions with exception to Buckley Cove during the modeled drought period. At Buckley Cove, modeled drought period San Joaquin River fractions would increase 13% in July and 24% in August when compared to No Action Alternative LLT (Appendix 8D, Source Water Fingerprinting). These increases would primarily balance through decreases in Sacramento River water and eastside tributary waters. Nevertheless, the San Joaquin River would only account for 37% of the total source water volume at Buckley Cove in July and August during the modeled drought period. As such, these modeled changes in the source water fractions of Sacramento, San Joaquin and Delta agriculture water are not of sufficient magnitude to substantially alter the long-term risk of pesticide-related toxicity to aquatic life, nor adversely affect other beneficial uses of the Delta.

SWP/CVP Export Service Areas

Assessment of effects in SWP/CVP Export Service Areas is based on effects seen in the Plan Area at the Banks and Jones pumping plants. Under Alternative 3 LLT, Sacramento River source water fractions would increase substantially at both Banks and Jones pumping plants relative to existing conditions, No Action Alternative NT and No Action Alternative LLT (Appendix 8D, Source Water Fingerprinting). At Banks pumping plant, Sacramento source water fractions would generally increase from 12-34% for the period of January through June (12-22% for March through May of the modeled drought period) and at Jones pumping plant Sacramento source water fractions would generally increase from 18-39% for the period of January through June (12-36% for February through June of the modeled drought period). These increases in Sacramento source water fraction would primarily balance through equivalent decreases in San Joaquin River water. Based on the general observation that San Joaquin River, in comparison to the Sacramento River, is a greater contributor of OP insecticides in terms of greater frequency of incidence and presence at concentrations exceeding water quality benchmarks, modeled increases in Sacramento River fraction at Banks and Jones would generally represent an improvement in export water quality respective to pesticides.

CEQA Conclusion: Relative to existing conditions, the Alternative 3 LLT would not result in any substantial change in long-term average pesticide concentration or result in substantial increase in the anticipated frequency with which long-term average pesticide concentrations would exceed aquatic life toxicity thresholds or other beneficial use effect thresholds upstream of the Delta, at the 11 assessment locations analyzed for the Delta, or the SWP/CVP service area. Numerous pesticides are currently used throughout the affected environment, and while some of these pesticides may be bioaccumulative, those present-use pesticides for which there is sufficient evidence for their presence in waters affected by SWP and CVP operations (i.e., diazinon, chlorpyrifos, diuron, and pyrethroids) are not considered bioaccumulative, and thus changes in their concentrations would not directly cause bioaccumulative problems in aquatic life or humans. Furthermore, while there are numerous 303(d) listings throughout the affected environment that name pesticides as the cause for beneficial use impairment, the modeled changes in upstream river flows and Delta source water fractions would not be expected to make any of these beneficial use impairments measurably worse. Because long-term average pesticide concentrations are not expected to increase substantially, no long-term water quality degradation with respect to pesticides is expected to occur and, thus, no adverse effects on beneficial uses would occur. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-22: Effects on pesticide concentrations resulting from implementation of CM2–CM22

Conservation components proposed under Alternative 3 would be the same as those proposed under Alternative 1A. As such, effects on pesticides resulting from the implementation of CM2–CM22would be similar to that previously discussed for Alternative 1A LLT. In summary, CM13 proposes the use of herbicides to control invasive aquatic vegetation around habitat restoration sites. Herbicides directly applied to water could include adverse effects on non-target aquatic life, such as aquatic invertebrates and beneficial aquatic plants. As such, aquatic life toxicity objectives could be exceeded with sufficient frequency and magnitude such that beneficial uses would be impacted.

CEQA Conclusion: Effects of CM2–CM22 on pesticides under Alternative 3 LLT are the similar as those discussed for Alternative 1A LLT. Potential environmental effects related only to CM13 are considered to be significant. Mitigation is required. While Mitigation Measure WQ-22 is available to partially reduce this impact of pesticides, no feasible mitigation is available that would reduce it to a level that would be less than significant.

Mitigation Measure WQ-22: Implement least toxic integrated pest management strategies

Please see Mitigation Measure WQ-22 under Impact WQ-22 in the discussion of Alternative 1A.

Impact WQ-23: Effects on phosphorus concentrations resulting from facilities operations and maintenance (CM1)

Effects of water facilities and operations (CM1) on phosphorus levels in water bodies of the affected environment under Alternative 3 LLT would be very similar (i.e., nearly the same) as those discussed for Alternative 1A LLT. Consequently, the environmental consequences to phosphorus levels discussed in detail for Alternative 1A LLT also adequately represent the effects under Alternative 3 LLT. Based on this finding, this impact is considered to be less than significant. No mitigation is required.

Impact WQ-24: Effects on phosphorus concentrations resulting from implementation of CM2–CM22

Effects of CM2–23 on phosphorus levels in water bodies of the affected environment under Alternative 3 LLT would be very similar (i.e., nearly the same) as those discussed for Alternative 1A LLT. Consequently, the environmental consequences to phosphorus levels from implementing CM2-CM22 discussed in detail for Alternative 1A LLT also adequately represent the effects of these same actions under Alternative 3 LLT. Based on this finding, this impact is considered to be less than significant. No mitigation is required.

Impact WQ-25: Effects on selenium concentrations resulting from facilities operations and maintenance (CM1)

[*Note to Lead Agencies: This assessment is in preparation*].

Impact WQ-26: Effects on selenium concentrations resulting from implementation of CM2–CM22

[*Note to Lead Agencies: This assessment is in preparation*].

Impact WQ-27: Effects on trace metal concentrations resulting from facilities operations and maintenance (CM1)

Upstream of the Delta

For the same reasons stated for the No Action Alternative LLT, Alternative 3 LLT would result in negligible, and likely immeasurable, increases in trace metal concentrations in the rivers and reservoirs upstream of the Delta, relative to existing conditions, No Action NT and No Action LLT. Effects due to the operation and maintenance of the conveyance facilities are expected to be immeasurable, on an annual and long-term average basis. As such, the Alternative 3 would not be expected to substantially increase the frequency with which applicable Basin Plan objectives or CTR criteria would be exceeded in water bodies of the affected environment located upstream of the Delta or substantially degrade the quality of these water bodies, with regard to trace metals.

Delta

For the same reasons stated for the No Action Alternative LLT, Alternative 3 LLT would not result in substantial increases in trace metal concentrations in the Delta relative to existing conditions, No Action NT, and No Action LLT. Effects due to the operation and maintenance of the conveyance facilities are expected to be negligible, on long-term average basis. As such, Alternative 3 would not be expected to substantially increase the frequency with which applicable Basin Plan objectives or CTR criteria would be exceeded in the Delta or substantially degrade the quality of Delta waters, with regard to trace metals.

SWP/CVP Export Service Areas

For the same reasons stated for the No Action Alternative LLT, Alternative 3 LLT would not result in substantial increases in trace metal concentrations in the water exported from the Delta or diverted from the Sacramento River through the proposed conveyance facilities. As such, there is not expected to be substantial changes in trace metal concentrations in the SWP/CVP export service area waters under Alternative 3, relative to existing conditions, No Action NT, and No Action LLT. As such, Alternative 3 would not be expected to substantially increase the frequency with which applicable Basin Plan objectives or CTR criteria would be exceeded in the water bodies of the affected environment in the SWP and CVP Service Area or substantially degrade the quality of these water bodies, with regard to trace metals.

CEQA Conclusion: There would be no substantial long-term increase in trace metal concentrations in the rivers and reservoirs upstream of the Delta, in the Delta Region, or the SWP/CVP export service area waters under Alternative 3 relative to existing conditions. As such, this alternative is not expected to cause additional exceedance of applicable water quality objectives by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. Because trace metal concentrations are not expected to increase substantially, no long-term water quality degradation for trace metals is expected to occur and, thus, no adverse effects to beneficial uses would occur. Furthermore, any negligible changes in long-term trace metal concentrations that may occur in water bodies of the affected environment would not be expected to make any existing beneficial use impairments measurably worse. The trace metals discussed in this assessment are not considered bioaccumulative, and thus would not directly cause bioaccumulative problems in aquatic life or humans. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-28: Effects on trace metal concentrations resulting from implementation of CM2–CM22

Conservation components proposed under Alternative 3 would be the same as those proposed under Alternative 1A. As such, effects on trace metals resulting from the implementation of CM2-CM22 would be similar to that previously discussed for Alternative 1A. As they pertain to trace metals, implementation of CM2-CM22 would not be expected to adversely affect beneficial uses of the affected environment or substantially degrade water quality with respect to trace metals.

CEQA Conclusion: Implementation of CM2-CM22 under Alternative 3 would not cause substantial long-term increase in trace metal concentrations in the rivers and reservoirs upstream of the Delta, in the Delta Region, or the SWP/CVP export service area. As such, this alternative is not expected to cause additional exceedance of applicable water quality objectives by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. Because trace metal concentrations are not expected to increase substantially, no long-term water quality degradation for trace metals is expected to occur and, thus, no adverse effects to beneficial uses would occur. Furthermore, any negligible changes in long-term trace metal concentrations that may occur throughout the affected environment would not be expected to make any existing beneficial use impairments measurably worse. The trace metals discussed in this assessment are not considered bioaccumulative, and thus would not directly cause bioaccumulative problems in aquatic life or humans. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-29: Effects on TSS and turbidity resulting from facilities operations and maintenance (CM1)

Effects of CM1 on TSS and turbidity under Alternative 3 are the same as those discussed for Alternative 1A LLT. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-30: Effects on TSS and turbidity resulting from implementation of CM2–CM22

Effects of CM2–CM22on TSS and turbidity under Alternative 3 are the same as those discussed for Alternative 1A LLT. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-31: Water quality effects resulting from construction-related activities

The conveyance features for CM1 under Alternative 3 would be very similar to those discussed for Alternative 1A. The primary difference between Alternative 3 and Alternative 1A is that under Alternative 3, the fewer number of intakes would result in a reduced level of construction activity. However, construction techniques and locations of major features of the conveyance system within the Delta would be similar. The remainder of the facilities constructed under Alternative 3, including conservation measures CM2-CM22, would be very similar to, or the same as, those to be constructed for Alternative 1A.

The types and magnitude of potential construction-related water quality effects associated with implementation of conservation measures CM1 under Alternative 3 would be very similar to the effects discussed for Alternative 1A LLT, and the effects anticipated with implementation of CM2-CM22 would be essentially identical. Nevertheless, the construction of CM1 with the environmental commitments and agency permitted construction requirements and BMPs would result in the potential water quality effects being largely avoided and minimized. The specific environmental commitments that would be implemented under Alternative 3 would be similar to those described for Alternative 1A Consequently, relative to existing conditions, Alternative 3 LLT would not be expected to cause exceedance of applicable water quality objectives/criteria or substantial water quality degradation with respect to constituents of concern, and thus would not adversely affect any beneficial uses upstream of the Delta, in the Delta, or in the SWP and CVP service area.

CEQA Conclusion: Construction-related contaminant discharges would be temporary and intermittent in nature and would involve negligible, if any, discharges of bioaccumulative or 303(d) listed constituents to water bodies of the affected environment. As such, construction activities would not contribute measurably to bioaccumulation of contaminants in organisms or humans or cause 303(d) impairments to be discernibly worse. Because environmental commitments would be implemented under Alternative 3 LLT for construction-related activities along with agency-issues permits that also contain construction requirements to protect water quality, the construction-related effects would not be expected to cause or contribute to a substantial increased frequency of exceedances of water quality objectives/criteria relative to existing conditions, or substantially degrade water quality with respect to the constituents of concern on a long-term average basis, and thus would not adversely affect any beneficial uses in water bodies upstream of the Delta, within the Delta, or in the SWP and CVP service area. Based on these findings, this impact is determined to be less than significant. No mitigation is required.

8.3.4.7 Alternative 4—Dual Conveyance with Tunnel and Intakes 1–3 (9,000 cfs; Operational Scenario B)

Alternative 4 would convey up to 9,000 cfs of water from the north Delta to the south Delta through pipelines/tunnels from three screened intakes on the east bank of the Sacramento River between Clarksburg and Walnut Grove. A new Byron Tract Forebay, adjacent to and south of Clifton Court Forebay, would be constructed which would provide water to the south Delta pumping plants. Water supply and conveyance operations would follow the guidelines described as Scenario B, which includes fall X2. Conservation measures 2-23 (CM2-23) would be implemented under this alternative, and would be the same as those under Alternative 1A. See Chapter 3 (Description of Alternatives) for additional details on Alternative 4.

Impact WQ-1: Effects on ammonia concentrations resulting from facilities operations and maintenance (CM1)

Upstream of the Delta

For the same reasons stated for the No Action Alternative LLT, Alternative 4 LLT would have negligible, if any, effect on ammonia concentrations in the rivers and reservoirs upstream of the Delta relative to existing conditions and the No Action Alternative NT and LLT. Any negligible increases in ammonia-N concentrations that could occur in the water bodies of the affected environment located upstream of the Delta would not be of frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the quality of these water bodies, with regard to ammonia.

Delta

Assessment of effects of ammonia under Alternative 4 LLT is the same as discussed under Alternative 1A, except that because flows in the Sacramento River at Freeport are different between the two alternatives, estimated monthly average and long term annual average predicted ammonia-N concentrations in the Sacramento River downstream of Freeport are different.

As Table 8-57 shows, estimated ammonia-N concentrations in the Sacramento River downstream of Freeport (upon full mixing of the SRWTP discharge with river water) under Alternative 4 LLT and the No Action Alternative LLT are expected to be similar. Minor increases in ammonia-N concentrations would occur during July through September, November through January, and in April, and remaining months would be unchanged or have a minor decrease. Annual average concentrations would be the same under both Alternative 4 LLT and the No Action Alternative LLT. Moreover, the estimated concentrations downstream of Freeport under Alternative 4 LLT would be similar to existing source water concentrations for the San Francisco Bay and San Joaquin River. Consequently, changes in source water fraction anticipated under Alternative 4 LLT, relative to the No Action Alternative LLT, are not expected to substantially increase ammonia concentrations at any Delta locations.

Any negligible increases in ammonia-N concentrations that could occur at certain locations in the Delta would not be of frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the water quality at these locations, with regards to ammonia.

Table 8-57. Estimated Ammonia-N (mg-L as N) Concentrations in the Sacramento River Downstream of the Sacramento Regional Wastewaster Treatment Plant for the No Action Alternative LLT and Alternative 4 LLT

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual Average
No Action Alternative LLT	0.081	0.073	0.061	0.055	0.053	0.055	0.061	0.070	0.072	0.064	0.072	0.069	0.063
Alternative 4 LLT	0.081	0.076	0.062	0.056	0.053	0.055	0.062	0.067	0.067	0.067	0.077	0.070	0.063

SWP/CVP Export Service Areas

The assessment of effects on ammonia in the SWP/CVP Export Service Area is based on assessment of ammonia-N concentrations at Banks and Jones pumping plants. Similar to the discussion for Alternative 1A, under Alternative 4 for areas of the Delta that are influenced by Sacramento River water, including Banks and Jones pumping plants, ammonia-N concentrations are expected to decrease, relative to existing conditions and No Action Alternative NT. This decrease in ammonia-N concentrations for water exported via the south Delta pumps is not expected to result in an adverse effects on beneficial uses or substantially degrade water quality of exported water, with regards to ammonia.

Furthermore, as discussed above for the PlanArea, for all areas of the Delta, including Banks and Jones pumping plants, ammonia-N concentrations are not expected to be substantially different under Alternative 4 LLT, relative to No Action Alternative LLT. Any negligible increases in ammonia-N concentrations that could occur at Banks and Jones pumping plants would not be of frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the water quality at these locations, with regards to ammonia.

***CEQA Conclusion*:** There would be no substantial, long-term increase in ammonia-N concentrations in the rivers and reservoirs upstream of the Delta, in the PlanArea, or the waters exported to the CVP and SWP service areas under Alternative 4 LLT relative to existing conditions. As such, this alternative is not expected to cause additional exceedance of applicable water quality objectives/criteria by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. Because ammonia concentrations are not expected to increase substantially, no long-term water quality degradation is expected to occur and, thus, no adverse effects on beneficial uses would occur. Ammonia is not 303(d) listed within the affected environment and thus any minor increases than could occur in some areas would not make any existing ammonia-related impairment measurably worse because no such impairments currently exist. Because ammonia-N is not bioaccumulative, minor increases that could occur in some areas would not bioaccumulate to greater levels in aquatic organisms that would, in turn, pose substantial health risks to fish, wildlife, or humans. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-2: Effects on ammonia concentrations resulting from implementation of CM2–CM22

Effects of CM2–CM22on ammonia under Alternative 4 LLT are the same as those discussed for Alternative 1A LLT. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-3:Effects on boron concentrations resulting from facilities operations and maintenance (CM1)

Upstream of the Delta

Effects of CM1 on boron under Alternative 4A LLT in areas upstream of the Delta would be very similar to the effects discussed for Alternative 1A LLT. There would be no expected change to the sources of boron in the Sacramento and east-side tributary watersheds, and resultant changes in flows from altered system-wide operations would have negligible, if any, effects on the concentration of boron in the rivers and reservoirs of these watersheds. The modeled long-term annual average lower San Joaquin River flow at Vernalis would decrease slightly compared to existing conditions and the No Action Alternative NT, and would be similar compared to the No Action Alternative LLT. The reduced flow would result in possible increases in long-term average boron concentrations of up to about 3% relative to the existing conditions and No Action Alternative NT conditions. The increased boron concentrations would not increase the frequency of exceedances of any applicable objectives or criteria and would not be expected to cause further degradation at measurable levels in the lower San Joaquin River, and thus would not cause the existing impairment there to be discernibly worse. Consequently, Alternative 4A LLT would not be expected to cause exceedance of boron objectives/criteria or substantially degrade water quality with respect to boron, and thus would not adversely affect any beneficial uses of the Sacramento River, the east-side tributaries, associated reservoirs upstream of the Delta, or the San Joaquin River.

Delta

Effects of CM1 on boron under Alternative 4A LLT in the Delta would be very similar to the effects discussed for Alternative 1A LLT. Relative to the existing conditions, No Action Alternative NT, and No Action Alternative LLT, Alternative 5A LLT would result in increased long-term average boron concentrations for the 16-year period modeled at interior and western Delta locations (by as much as 9% at the SF Mokelumne River at Staten Island, 3% at the San Joaquin River at Buckley Cove, 18% at Franks Tract, 18% at Old River at Rock Slough, and 5% at the Sacramento River at Emmaton) (Appendix 8F, Table Bo-12). Implementation of tidal habitat restoration under conservation measure CM4 also may contribute to increased boron concentrations at western Delta assessment locations, and thus would not be anticipated to substantially affect agricultural diversions which occur primarily at interior Delta locations. The long-term annual average and monthly average boron concentrations, for either the 16-year period or drought period modeled, would never exceed the 2,000 μg/L human health advisory objective (i.e., for children) or 500 μg/L agricultural objective at any of the eleven Delta assessment locations, which represents no change from the existing conditions and No Action Alternative NT and LLT conditions (Appendix 8F, Table Bo-3). Reductions in long-term average assimilative capacity of up to 11% at interior Delta locations (i.e., Franks Tract and Old River at Rock Slough) would be small with respect to the 500 μg/L agricultural objective (Appendix 8F, Table Bo-13). However, because the absolute boron concentrations would still be well below the lowest 500 μg/L objective for the protection of the agricultural beneficial use under Alternative 4A LLT, the levels of boron degradation would not be of sufficient magnitude to substantially increase the risk of exceeding objectives or cause adverse effects to municipal and agricultural water supply beneficial uses, or any other beneficial uses, in the Delta (Appendix 8F, Figure Bo-3).

SWP/CVP Export Service Areas

Effects of CM1 on boron under Alternative 4A LLT in the Delta would be very similar to the effects discussed for Alternative 1A LLT. Under Alternative 4A LLT, long-term average boron concentrations would decrease by as much as 24% at the Banks Pumping Plant and by as much 27% at Jones Pumping Plant relative to existing conditions, No Action Alternative NT, and No Action Alternative LLT (Appendix 8F, Table Bo-12). Commensurate with the decrease in exported boron concentrations, boron concentrations in the lower San Joaquin River may be reduced and would likely alleviate or lessen any expected increase in boron concentrations at Vernalis associated with flow reductions (see discussion of Upstream of the Delta), as well locations in the Delta receiving a large fraction of San Joaquin River water. Reduced export boron concentrations also may contribute to reducing the existing 303(d) impairment in the lower San Joaquin River and associated TMDL actions for reducing boron loading.

Maintenance of SWP and CVP facilities under Alternative 4A LLT would not be expected to create new sources of boron or contribute towards a substantial change in existing sources of boron in the affected environment. Maintenance activities would not be expected to cause any substantial increases in boron concentrations or degradation with respect to boron such that objectives would be exceeded more frequently, or any beneficial uses would be adversely affected anywhere in the affected environment.

CEQA Conclusion: Boron is not a bioaccumulative constituent, thus any increased concentrations under Alternative 4A LLT would not result in adverse boron bioaccumulation effects to aquatic life or humans. Relative to existing conditions, Alternative 4A LLT would not result in any substantial increases in boron concentration upstream of the Delta. Alternative 4A LLT maintenance also would not result in any substantial increases in boron concentrations in the affected environment. Relative to existing conditions, Alternative 4A LLT would not result in substantially increased boron concentrations such that frequency of exceedances of municipal and agricultural water supply objectives would increase. The levels of boron degradation that may occur under Alternative 4A LLT would not be of sufficient magnitude to cause substantially increased risk for adverse effects to municipal or agricultural beneficial uses within the affected environment. Long-term average boron concentrations would decrease in Delta water exports to the SWP and CVP service area, which may contribute to reducing the existing 303(d) impairment of agricultural beneficial uses in the lower San Joaquin River. Based on these findings, this impact is determined to be less than significant. No mitigation is required.

Impact WQ-4: Effects on boron concentrations resulting from implementation of CM2–CM22

Effects of CM2-CM22 on boron under Alternative 4A LLT are the same as those discussed for Alternative 1A LLT. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-5: Effects on bromide concentrations resulting from facilities operations and maintenance (CM1)

Upstream of the Delta

Under Alternative 4 LLT there would be no expected change to the sources of bromide in the Sacramento and eastside tributary watersheds. Bromide loading in these watersheds would remain unchanged and resultant changes in flows form altered system-wide operations under Alternative 4 LLT would have negligible, if any, effects on the concentration of bromide in the rivers and reservoirs of these watersheds. Consequently, Alternative 4 LLT would not be expected to adversely affect the MUN beneficial use, or any other beneficial uses, of the Sacramento River, the eastside tributaries, or their associated reservoirs upstream of the Delta.

Under Alternative 4 LLT, modeling indicates that long-term annual average flows on the San Joaquin River would decrease by 6%, relative to existing conditions, 5% relative to No Action Alternative NT, and would remain virtually the same relative to No Action Alternative LLT. Similar to the No Action Alternative LLT, these decreases in flow would result in possible increase in long-term average bromide concentrations of about 3%, relative to existing conditions, 2% relative to No Action Alternative NT, and less than <1% relative to No Action Alternative LLT. The small increases in lower San Joaquin River bromide levels that could occur under Alternative 4 LLT, relative to existing, No Action Alternative NT, and No Action Alternative LLT conditions would not be expected to adversely affect the MUN beneficial use, or any other beneficial uses, of the lower San Joaquin River.

Delta

Under Alternative 4 LLT, the geographic extent of effects pertaining to long-term average bromide concentrations in the Delta would be similar to that previously described for Alternative 1A LLT, although the magnitude of predicted long-term change and relative frequency of concentration threshold exceedances would be different. Relative to existing conditions, modeled long-term average bromide concentrations would increase at Staten Island, Emmaton (during the drought period only), and Barker Slough, while modeled long-term average bromide concentrations would decrease at the other assessment locations (Appendix 8E, Bromide Table 10-11). Overall effects would be greatest at Barker Slough, where predicted long-term average bromide concentrations would increase from 51 μg/L to 63 μg/L (22% relative increase) for the modeled 16-year hydrologic period and would increase from 54 μg/L to 94 μg/L (75% relative increase) for the modeled drought period. At Barker Slough, the predicted 50 μg/L exceedance frequency would decrease from 49% under existing conditions to 38% under Alternative 4 LLT, but would increase from 55% to 63% during the drought period. At Barker Slough, the predicted 100 μg/L exceedance frequency would increase from 0% under existing conditions to 17% under Alternative 4 LLT, and would increase from 0% to 38% during the drought period. In contrast, increases in bromide at Staten Island would result in a 50 µg/L bromide threshold exceedance increase from 47% under existing conditions to 73% under Alternative 4 LLT (52% to 78% during the modeled drought period). However, unlike Barker Slough, modeling shows that long-term average bromide concentration at Staten Island would exceed the 100 µg/L assessment threshold concentration 1% under existing conditions and 4% under Alternative 4 LLT (0% to 2% during the modeled drought period). The long-term average bromide concentrations would be 62 µg/L (63 µg/L for the modeled drought period) at Staten Island under Alternative 4 LLT. Changes in exceedance frequency of the 50 µg/L and 100 µg/L concentration thresholds, as well as relative change in long-term average concentration, at other assessment locations would be less substantial.

Due to the relatively small differences between modeled existing conditions and No Action baselines, changes in long-term average bromide concentrations and changes in exceedance frequencies relative to No Action Alternative NT and No Action Alternative LLT are generally of similar magnitude to those previously described for the existing condition comparison (Appendix 8E, Bromide Table 10-11). Modeled long-term average bromide concentration increases would similarly be greatest at Barker Slough, where long-term average concentrations are predicted to increase by 28% (79% for the modeled drought period) relative to No Action Alternative NT, and would increase by 26% (75% for the modeled drought period) relative to No Action Alternative LLT. However, unlike the existing conditions comparison, long-term average bromide concentrations at Buckley Cove under Alternative 4 LLT would increase relative to No Action Alternative NT and No Action Alternative LLT, although the increases would be relatively small (≤4%).

The increase in long-term average bromide concentrations predicted at Barker Slough, principally the relative increase in 100 µg/L exceedance frequency, would result in a substantial change in source water quality for existing drinking water treatment plants drawing water from the North Bay Aqueduct. As discussed for Alternative 1A, drinking water treatment plants obtaining water via the North Bay Aqueduct utilize a variety of conventional and enhanced treatment technologies in order to achieve DBP drinking water criteria. While the implications of such a modeled change in bromide at Barker Slough are difficult to predict, the substantial modeled increases could lead to adverse changes in the formation of disinfection byproducts such that considerable treatment plant upgrades may be necessary in order to achieve equivalent levels of health protection.

The seasonal intakes at Mallard Slough and City of Antioch are infrequently used due to water quality constraints related to sea water intrusion. On a long-term average basis, bromide at these locations is in excess of 3,000 µg/L, but during seasonal periods of high Delta outflow can be <300 µg/L. Use of the seasonal intakes at Mallard Slough and City of Antioch under Alternative 4 LLT would experience a period average increase in bromide during the months when these intakes would most likely be utilized. For those wet and above normal water year types where mass balance modeling would predict water quality typically suitable for diversion, predicted long-term average bromide would increase from 103 µg/L to 165 µg/L (61% increase) at City of Antioch and would increase from 150 µg/L to 210 µg/L (41% increase) at Mallard Slough relative to existing conditions (Appendix 8E, Bromide Figure 4-5). Increases would be similar for No Action Alternative NT and No Action Alternative LLT comparison. The decisions surrounding the use of these seasonal intakes is largely driven by acceptable water quality, and thus have historically been opportunistic. Opportunity to use these intakes would remain, and the predicted increases in bromide concentrations at the City of Antioch and Mallard Slough intake would not be expected to adversely affect MUN beneficial uses, or any other beneficial use, at these locations.

SWP/CVP Export Service Areas

Under Alternative 4 LLT, improvement in long-term average bromide concentrations would occur at the Banks and Jones pumping plants. Long-term average bromide concentrations for the modeled 16-year hydrologic period at these locations would decrease by as much as 46% relative to existing conditions, 42% relative to No Action Alternative NT, and 39% relative to No Action Alternative LLT. Relative change in long-term average bromide concentration would be less during drought conditions (≤34%), but would still represent considerable improvement (Appendix 8E, Bromide Tables 10-11). As a result, less frequent bromide concentration exceedances of the 50 µg/L and 100 µg/L assessment thresholds would be predicted and an overall improvement in Export Service Areas water quality would be experienced respective to bromide. Commensurate with the decrease in exported bromide, an improvement in lower San Joaquin River bromide would also be observed since bromide in the lower San Joaquin River is principally related to irrigation water deliveries from the Delta. While the magnitude of this expected lower San Joaquin River improvement in bromide is difficult to predict, the relative decrease in overall loading of bromide to the Export Service Areas would likely alleviate or lessen any expected increase in bromide concentrations at Vernalis (see discussion of Upstream of the Delta) as well locations in the Delta receiving a large fraction of San Joaquin River water, such as much of the south Delta.

Similar to the discussion pertaining to the No Action Alternative LLT, maintenance of SWP and CVP facilities under Alternative 4 LLT would not be expected to create new sources of bromide or contribute towards a substantial change in existing sources of bromide in the affected environment. Maintenance activities would not be expected to cause any substantial change in bromide such that MUN beneficial uses, or any other beneficial use, would be adversely affected anywhere in the affected environment.

CEQA Conclusion: Relative to existing conditions, Alternative 4 LLT operation and maintenance would not result in any substantial change in long-term average bromide concentration upstream of the Delta. Furthermore, under Alternative 4 LLT, water exported from the Delta to the SWP/CVP service area would be substantially improved relative to bromide. Bromide is not bioaccumulative, therefore change in long-term average bromide concentrations would not directly cause bioaccumulative problems in aquatic life or humans. Additionally, bromide is not a constituent related to any 303(d) listings. Alternative 4 LLT operation and maintenance activities would not cause substantial long-term degradation to water quality respective to bromide with the exception of water quality at Barker Slough, source of the North Bay Aqueduct. At Barker Slough, modeled long-term annual average concentrations of bromide would increase by 22%, and 75% during the modeled drought period. For the modeled 16-year hydrologic period the frequency of predicted bromide concentrations exceeding 100 µg/L would increase from 0% under existing conditions to 17% under Alternative 4 LLT, while for the modeled drought period, the frequency would increase from 0% to 38%. Substantial changes in long-term average bromide could necessitate changes in treatment plant operation or require treatment plant upgrades in order to maintain DBP compliance. The model predicted change at Barker Slough is substantial and, therefore, would represent a substantially increased risk for adverse effects on existing MUN beneficial uses should treatment upgrades not be undertaken. The impact is considered significant and mitigation is required. Implementation of Mitigation Measure WQ-5 would reduce identified impacts to a less-than-significant level by relocating the North Bay Aqueduct outside the influence of sea water intrusion.

Mitigation Measure WQ-5: Move the North Bay Aqueduct intake from Barker Slough to the Sacramento River

Please see Mitigation Measure WQ-5 under Impact WQ-5 in the discussion of Alternative 1A.

Impact WQ-6: Effects on bromide concentrations resulting from implementation of CM2–CM22

Conservation components proposed under Alternative 4 LLT would be the same as those proposed under Alternative 1A LLT. As discussed for Alternative 1A LLT, implementation of the CM2-CM22 would not present new or substantially changed sources of bromide to the project area. Some conservation measures may replace or substitute for existing irrigated agriculture in the Delta. This replacement or substitution is not expected to substantially increase or present new sources of bromide. CM2-CM22 would not be expected to cause any substantial change in bromide such that MUN beneficial uses, or any other beneficial use, would be adversely affected anywhere in the affected environment.

CEQA Conclusion: Conservation components proposed under Alternative 4 LLT would be similar to those proposed under Alternative 1A LLT. As such, effects on bromide resulting from the implementation of CM2-CM22 would be similar to that previously discussed for Alternative 1A LLT. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-7: Effects on chloride concentrations resulting from facilities operations and maintenance (CM1)

Upstream of the Delta

Under Alternative 4 LLT there would be no expected change to the sources of chloride in the Sacramento and eastside tributary watersheds. Chloride loading in these watersheds would remain unchanged and resultant changes in flows from altered system-wide operations would have negligible, if any, effects on the concentration of chloride in the rivers and reservoirs of these watersheds. The modeled long-term annual average flows on the lower San Joaquin River at Vernalis would decrease slightly compared to existing conditions and the No Action Alternative NT, and be similar compared to the No Action Alternative LLT. The reduced flow would result in possible increases in long-term average chloride concentrations of about 2%, relative to the existing conditions and No Action Alternative NT conditions, and no change relative to No Action Alternative LLT. Consequently, Alternative 4A LLT would not be expected to cause exceedance of chloride objectives/criteria or substantially degrade water quality with respect to chloride, and thus would not adversely affect any beneficial uses of the Sacramento River, the eastside tributaries, associated reservoirs upstream of the Delta, or the San Joaquin River.

Delta

Relative to existing conditions, Alternative 4 LLT would result in similar or reduced long-term average chloride concentrations for the 16-year period modeled at nine of the assessment locations, and increased concentrations at the North Bay Aqueduct at Barker Slough (up 34%) and San Joaquin River at Staten Island (up 47%) (Appendix 8G, Chloride Table Cl-17). Additionally, implementation of tidal habitat restoration under conservation measure CM4 would increase the tidal exchange volume in the Delta, and thus may contribute to increased chloride concentrations in the Bay source water as a result of increased salinity intrusion. Consequently, while uncertain, the magnitude of chloride increases may be greater than indicated herein and would affect the western Delta assessment locations the most which are influenced to the greatest extent by the Bay source water. The following outlines the modeled chloride changes relative to the applicable objectives and beneficial uses of Delta waters.

Municipal Beneficial Uses

Relative to the 150 mg/L Bay-Delta WQCP objective for municipal and industrial beneficial uses, the plots of monthly average chloride concentrations at the Contra Costa Canal at Pumping Plant #1 for the separate water year types indicates that the number of months above the objective would remain unchanged or decrease compared to the existing conditions (Appendix 8G, Figure Cl-6). The modeled chloride concentrations at the San Joaquin River at Antioch location would never meet this objective; however, this represents no change from the existing conditions.

With respect to the 250 mg/L Bay-Delta WQCP objective, the modeled frequency of exceedances based on monthly average chloride concentrations would decrease at the Contra Costa Canal at Pumping Plant #1 (Appendix 8G, Table Cl-18 and Figure Cl-7). The frequency of exceedances would increase for the 16-year period modeled at the San Joaquin River at Antioch (i.e., from 66% under existing conditions to 69%) and Sacramento River at Mallard Island (i.e., from 85% under existing conditions to 88%) (Appendix 8G, Table Cl-18), and would cause further degradation at Antioch in March and April (i.e., maximum reduction of 54% of the assimilative capacity for the 16-year period modeled, and 100% reduction, or elimination of assimilative capacity, during the drought period modeled) (Appendix 8G, Table Cl-19 and Figure Cl-7). Based on the additional seasonal exceedances of the municipal objective and magnitude of long-term average water quality degradation with respect to chloride in the western Delta, the potential exists for substantial adverse effects on the municipal and industrial beneficial uses through reduced opportunity for diversion of water with acceptable salinity.

Aquatic Life Beneficial Uses

Relative to the 230 mg/L chronic EPA aquatic life criterion, monthly average chloride concentrations at the northern and eastern Delta locations would not exceed the criteria and the frequency of exceedances at most interior and southern Delta locations would decrease for the 16-year period modeled (Appendix 8G, Table Cl-18). Reductions in the modeled assimilative capacity at interior Delta locations (i.e., Franks Tract and Old River at Rock Slough) would occur during the January through June period when concentrations would be well below the criterion, and thus, would not adversely affect aquatic organisms (Appendix 8G, Table Cl-20 and Figure Cl-8).

303(d) Listed Water Bodies

With respect to the 303(d) listing for chloride in Tom Paine Slough, the monthly average chloride concentrations for the 16-year period modeled at Old River at Tracy Road would generally be similar compared to existing conditions, and thus, would not be further degraded on a long-term basis (Appendix 8G, Figure Cl-8). With respect to Suisun Marsh, the monthly average chloride concentrations for the 16-year period modeled would generally increase compared to existing conditions in some months during October through May at the Sacramento River at Collinsville (Appendix 8G, Figure Cl-9), Mallard Island (Appendix 8G, Figure Cl-7), and increase substantially at Montezuma Slough at Beldon's Landing (i.e., over a doubling of concentration in December through February) (Appendix 8G, Figure Cl-10), thereby contributing to additional, measureable long-term degradation that potentially would adversely affect the necessary actions to reduce chloride loading for any TMDL that is developed.

Relative to the No Action Alternative NT and No Action Alternative LLT conditions, Alternative 4 LLT would result in similar or reduced long-term average chloride concentrations for the 16-year period modeled at eight of the assessment locations and increased concentrations at the SF Mokelumne River at Staten Island (up to 22%), San Joaquin River at Buckley Cove (up to 2%), Sacramento River at Emmaton (up to 10%), and the North Bay Aqueduct at Barker Slough (up to 23%) compared to the No Action Alternative NT conditions (Appendix 8G, Table Cl-17). The modeled chloride changes relative to the applicable objectives and potential effects on beneficial uses are as follows.

SWP/CVP Export Service Areas

Under Alternative 4 LLT, long-term average chloride concentrations for the 16-year period modeled at the Banks and Jones pumping plants would decrease by as much as 46% relative to existing conditions, 41% relative to No Action Alternative NT, and 38% compared to No Action Alternative LLT (Appendix 8G, Chloride Table Cl-17). The modeled frequency of exceedances of applicable water quality objectives/criteria would decrease relative to existing conditions, No Action Alternative NT, and No Action Alternative LLT, for both the 16-year period and the drought period modeled (Appendix 8G, Chloride Table Cl-18). Consequently, water exported into the SWP/CVP service area would generally be of similar or better quality with regards to chloride relative to existing conditions and the No Action Alternative NT and No Action Alternative LLT conditions.

Commensurate with the reduced chloride concentrations in water exported to the service area, reduced chloride loading in the lower San Joaquin River would be anticipated which would likely alleviate or lessen any expected increase in chloride at Vernalis related to decreased annual average San Joaquin River flows (see discussion of Upstream of the Delta).

Maintenance of SWP and CVP facilities would not be expected to create new sources of chloride or contribute towards a substantial change in existing sources of chloride in the affected environment. Maintenance activities would not be expected to cause any substantial change in chloride such that any long-term water quality degradation would occur, thus, beneficial uses would not be adversely affected anywhere in the affected environment.

CEQA Conclusion**:** Chloride is not a bioaccumulative constituent, thus any increased concentrations under Alternative 4 LLT would not result in adverse chloride bioaccumulation effects on aquatic life or humans. Alternative 4 LLT maintenance would not result in any substantial changes in chloride concentration upstream of the Delta or in the SWP/CVP service area. Relative to existing conditions, the Alternative 4A LLT would result in substantially increased chloride concentrations such that frequency of exceedances of the 250 mg/L Bay-Delta WQCP objective would increase at the San Joaquin River at Antioch and at Mallard Slough (by 3% each), and long-term degradation may occur, that may result in adverse effects on the municipal and industrial water supply beneficial use. Relative to the existing conditions, the modeled increased chloride concentrations and degradation in the western Delta could further contribute, at measurable levels (i.e., over a doubling of concentration), to the existing 303(d) listed impairment due to chloride in Suisun Marsh for the protection of fish and wildlife. Based on these findings, this impact is determined to be potentially significant due to increased chloride concentrations and degradation at western Delta locations and its effects on municipal and industrial water supply and fish and wildlife beneficial uses.

While implementation of Mitigation Measure WQ-7 may reduce this impact, the feasibility and effectiveness of this mitigation measures is uncertain. Therefore, the mitigation would not necessarily reduce the impact to a level that would be less than significant.

Mitigation Measure WQ-7: Conduct additional evaluation and modeling of increased chloride levels and develop and implement phased actions to reduce levels

Please see Mitigation Measure WQ-7 under Impact WQ-7 in the discussion of Alternative 1A.

Impact WQ-8: Effects on chloride concentrations resulting from implementation of CM2–CM22

Under Alternative 4A LLT, the types and geographic extent of effects on chloride concentrations in the Delta as a result of implementation of the other conservation measures (i.e., CM2-CM22) would be similar to, and undistinguishable from, those effects previously described for Alternative 1A LLT. The conservation measures would present no new direct sources of chloride to the affected environment. Moreover, some habitat restoration conservation measures (CM4-10) would occur on lands within the Delta currently used for irrigated agriculture, thus replacing agricultural land uses with restored tidal wetlands, floodplain, and related channel margin and off-channel habitats. The potential reduction in irrigated lands within the Delta may result in reduced discharges of agricultural field drainage with elevated chloride concentrations, which would be considered an improvement compared to existing conditions.

***CEQA Conclusion*:** Implementation of the CM2-CM22 for Alternative 4A LLT would not present new or substantially changed sources of chloride to the affected environment upstream of the Delta, within Delta, or in the SWP/CVP service area. Replacement of irrigated agricultural land uses in the Delta with habitat restoration conservation measures may result in some reduction in discharge of agricultural field drainage with elevated chloride concentrations, thus resulting in improved water quality conditions. Based on these findings, this impact is considered to be less than significant. No mitigation is required.

Impact WQ-9: Effects on dissolved oxygen resulting from facilities operations and maintenance (CM1)

Effects of CM1 on DO under Alternative 4 are the same as those discussed for Alternative 1A LLT. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-10: Effects on dissolved oxygen resulting from implementation of CM2-CM22

Effects of CM2–23 on DO under Alternative 4 are the same as those discussed for Alternative 1A LLT. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-11: Effects on electrical conductivity concentrations resulting from facilities operations and maintenance (CM1)

Upstream of the Delta

For the same reasons stated for the No Action Alternative LLT, EC levels (highs, lows, typical conditions) in the Sacramento River and its tributaries, the eastside tributaries, their associated reservoirs, and the San Joaquin River upstream of the Delta under Alternative 4 LLT are not expected to be outside the ranges occurring under existing conditions or would occur under the No

Action Alternative NT and LLT. Any minor changes in EC levels that could occur under Alternative 4 LLT in water bodies upstream of the Delta would not be of sufficient magnitude, frequency and geographic extent that would cause adverse effects on beneficial uses or substantially degrade water quality with regard to EC.

Delta

In the Delta region, the changes in frequency of exceedance of Bay-Delta WQCP EC objectives would be very similar as that described for Alternative 2A LLT, except that there would be two fewer days of exceedance in the San Joaquin River at Jersey Point and five fewer days of exceedance in the San Joaquin River at San Andreas Landing (Appendix H, Table EC-4). The change in average EC levels for the entire period modeled (1976-1991) and the drought period modeled (1987-1991), relative to existing conditions and the No Action Alternative NT and LLT, would either be the same as or ±1 µmhos/cm different than that described for Alternative 2A LLT (Appendix H, Table EC-15). Average EC in Suisun Marsh for the entire period modeled would also be very similar to that described for Alternative 2A LLT, except in Montezuma Slough at National Steel where average EC would be 0.1 mS/cm higher than that described for Alternative 2A LLT (Appendix H, Tables EC-21 through EC-25).

SWP/CVP Export Service Area

In the SWP/CVP Export Service Areas, average EC would decrease relative to existing conditions and the No Action Alternative NT and LLT such that there would be no exceedance of the Bay-Delta WQCP export area EC objective at the Banks and Jones pumping plants. Alternative 4 LLT would improve EC levels in the SWP/CVP Export Service Areas.

***CEQA Conclusion*:** For the reasons described for Alternative 2A LLT, impacts on EC in the interior and southern Delta are considered to be potentially significant. Impacts to EC in Suisun Marsh also are considered to be potentially significant. While Mitigation Measure 11 (see Alternative 1A) may reduce these impacts, the feasibility and effectiveness of this mitigation measures is uncertain. Therefore, the available mitigation would not necessarily reduce the impact to a level that would be less than significant.

Impact WQ-12: Effects on electrical conductivity resulting from implementation of CM2-CM22

Effects of CM2-CM22 on EC under Alternative 4 LLT are the same as those discussed for Alternative 1A LLT. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-13: Effects on mercury concentrations resulting from facilities operations and maintenance (CM1)

[Text pending]

Impact WQ-14: Effects on mercury concentrations resulting from implementation of CM2–23

[Text pending]

Impact WQ-15: Effects on nitrate concentrations resulting from facilities operations and maintenance (CM1)

Upstream of the Delta

For the same reasons stated for the No Action Alternative LLT, Alternative 4 LLT would have negligible, if any, impact on nitrate concentrations in the rivers and reservoirs upstream of the Delta in the Sacramento River watershed relative to existing conditions and the No Action Alternative NT and LLT.

Under Alternative 4 LLT, modeling indicates that long-term annual average flows on the San Joaquin River would decrease by an estimated 6%, relative to existing conditions, 5% relative to No Action NT, and would remain virtually the same relative to No Action LLT (crossreference to Modeling Data Appendix, CALSIM Flow Data for Vernalis). Given these relatively small decreases in flows and the weak correlation between nitrate and flows in the San Joaquin River (see Nitrate Appendix J Figure 2), it is expected that nitrate concentrations in the San Joaquin River will be minimally affected, if at all, by changes in flow rates under Alternative 4 LLT.

Any negligible changes in nitrate-N concentrations that may occur in the water bodies of the affected environment located upstream of the Delta would not be of frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the quality of these water bodies, with regards to nitrate.

Delta

Results of the mixing calculations indicate that under Alternative 4 LLT, relative to existing conditions, No Action NT, and No Action LLT, nitrate concentrations throughout the Delta are anticipated to remain low (<1.4 mg/L-N) relative to adopted objectives (Nitrate Appendix J Table 16 and 17). Although changes at specific Delta locations and for specific months may be substantial on a relative basis, the absolute concentration of nitrate in Delta waters would remain low (<1.4 mg/L-N) in relation to the drinking water MCL of 10 mg/L-N, as well as all other thresholds identified in Table XX. Long-term average nitrate concentrations are anticipated to remain below 1 mg/L-N at all 11 assessment locations except the San Joaquin River at Buckley Cove, where long-term average concentrations would be somewhat above 1 mg/L-N. Nevertheless, at this location, long-term average nitrate concentration would be somewhat reduced under Alternative 4 LLT, relative to existing conditions, similar to the No Action NT, and slightly increased relative to the No Action LLT. No additional exceedances of the MCL are anticipated at any location (Nitrate Appendix J Table 16). On a monthly average basis and on a long term annual average basis, for all modeled years and for the drought period (1987-1991) only, use of assimilative capacity available under existing conditions, No Action NT, and No Action LLT, relative to the drinking water MCL of 10 mg/L-N, was low or negligible (i.e., <5%) for all locations and months, except San Joaquin River at Buckley Cove in August, which showed a 6.4% use of assimilative capacity available under the No Action LLT, for the drought period (1987-1991) (Nitrate Appendix J Table 18).

Nitrate concentrations will likely be higher than the modeling results indicate in certain locations, including: (1) in the Sacramento River between Freeport and Mallard Island and other areas in the Delta downstream of Freeport that are influenced by Sacramento River water, the increase becoming greater with increasing distance downstream, due to conversion of ammonia from the SRWTP discharge at Freeport (under existing conditions and No Action Alternative NT only, since upgrades to SRWTP that substantially reduce ammonia concentrations in the Sacramento River downstream of Freeport are assumed in the LLT; see the Ammonia section of this chapter for further discussion); (2) immediately downstream of wastewater treatment plants that practice nitrification, but not denitrification (e.g., City of Rio Vista Beach WWTF, Town of Discovery Bay WWTF, City of Stockton RWCF).

The effect of (1) (above) is expected to be small, on the order of 1 mg/L nitrate as N or less in the existing conditions and No Action Alternative NT. This is because the existing increase appears to be from approximately 0.1 mg/L-N to approximately 0.4-0.5 mg/L-N over this reach, due to approximately a 1:1 conversion of ammonia-N to nitrate-N (CVWQCB 2010:32). Because this nitrate is assumed not to be generated under Alternative 4 LLT, average concentrations would be expected to decrease under Alternative 4 LLT in this reach of the Sacramento River relative to existing conditions and the No Action Alternative NT. Regarding number (2) (above), for all such facilities in the Delta, the Regional Water Boards have issued NPDES permits that allow discharge of wastewater containing nitrate into the Delta, and under these permits, the State has determined that no beneficial uses are adversely affected by the discharge, and that the discharger's use of available assimilative capacity of the water body is acceptable. When dilution is necessary in order for the discharge to be in compliance with the Basin Plans (which incorporate the 10 mg/L-N MCL by reference), not all of the assimilative capacity of the receiving water is granted to the discharger. Thus, limited decreases in flows are not anticipated to result in systemic exceedances of the MCLs by these POTWs. Furthermore, NPDES permits are renewed on a 5-year basis, and thus, if under changes in flows, dilution was no longer sufficient to maintain nitrate below the MCL in the receiving water, the NPDES permit renewal process would address such cases.

Therefore, any increases in nitrate-N concentrations that may occur at certain locations within the Delta would not be of frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the water quality at these locations, with regards to nitrate.

SWP/CVP Export Service Areas

Assessment of effects of nitrate in the SWP and CVP Export Service Areas is based on effects on nitrate-N at the Banks and Jones pumping plants.

Results of the mixing calculations indicate that under Alternative 4 LLT, relative to existing conditions, No Action NT, and No Action LLT, nitrate concentrations at Banks and Jones pumping plants are anticipated to decrease on a long-term average annual basis (Nitrate Appendix J Table 16 and 17). During the late summer, particularly in the drought period assessed, concentrations are expected to increase substantially on a relative basis (i.e., >50%), but the absolute value of these changes (i.e., in mg/L-N) is small. Additionally, given the many factors that contribute to potential algal blooms in the SWP and CVP canals within the Export Service Area, and the lack of studies that have shown a direct relationship between nutrient concentrations in the canals and reservoirs and problematic algal blooms in these water bodies, there is no basis to conclude that these small (i.e., generally <0.3 mg/L-N), seasonal increases in nitrate concentrations would increase the potential for problem algal blooms in the SWP and CVP Export Service Area. No additional exceedances of the MCL are anticipated (Nitrate Appendix J Table 16). On a monthly average basis and on a long term annual average basis, for all modeled years and for the drought period (1987-1991) only, use of assimilative capacity available under existing conditions and No Action NT, relative to the 10 mg/L-N MCL, was negligible for both Banks and Jones pumping plants (Nitrate Appendix J Table 18).

Any increases in nitrate-N concentrations that may occur in water exported via Banks and Jones pumping plants are not expected to result in an adverse effects to beneficial uses or substantially degrade the quality of exported water, with regards to nitrate.

CEQA Conclusion: There would be no substantial, long-term increase in nitrate-N concentrations in the rivers and reservoirs upstream of the Delta, in the Delta Region, or the waters exported to the CVP and SWP service areas under Alternative 4 LLT relative to existing conditions. As such, this alternative is not expected to cause additional exceedance of applicable water quality objectives/criteria by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. Because nitrate concentrations are not expected to increase substantially, no long-term water quality degradation is expected to occur and, thus, no adverse effects to beneficial uses would occur. Nitrate is not 303(d) listed within the affected environment and thus any increases than may occur in some areas and months would not make any existing nitrate-related impairment measurably worse because no such impairments currently exist. Because nitrate is not bioaccumulative, increases that may occur in some areas and months would not bioaccumulate to greater levels in aquatic organisms that would, in turn, pose substantial health risks to fish, wildlife, or humans. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-16: Effects on nitrate concentrations resulting from implementation of CM2–23

Effects of CM2–23 on nitrate under Alternative 4 LLT are the same as those discussed for Alternative 1A LLT. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-17: Effects on dissolved organic carbon concentrations resulting from facilities operations and maintenance (CM1)

Upstream of the Delta

Under Alternative 4 LLT, there would be no substantial change to the sources of DOC within the watersheds upstream of the Delta. Moreover, long-term average flow and DOC levels in the Sacramento River at Hood and San Joaquin River at Vernalis are poorly correlated. Thus changes in system operations and resulting reservoir storage levels and river flows would not be expected to cause a substantial long-term change in DOC concentrations in the water bodies upstream of the Delta. Any negligible changes in DOC levels in water bodies upstream of the Delta under Alternative 4 LLT, relative to existing conditions and the No Action Alternative NT and LLT, would not be of sufficient frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the quality of these water bodies, with regards to DOC.

Delta

Under Alternative 4 LLT, the geographic extent of effects pertaining to long-term average DOC concentrations in the Delta would be similar to that previously described for Alternative 1A LLT, although the magnitude of predicted long-term change and relative frequency of concentration threshold exceedances would be slightly greater. Modeled effects would be greatest at Franks Tract, Rock Slough, and Contra Costa PP No. 1., where for the 16-year hydrologic period and the modeled drought period, long-term average concentration increases ranging from 0.3-0.4 mg/L would be predicted (≤12% net increase) (Appendix 8K, DOC Table 5). Increases in long-term average concentrations would correspond to more frequent concentration threshold exceedances, with the greatest change occurring at Rock Slough and Contra Costa PP No. 1 locations. For Rock Slough, long-term average DOC concentrations exceeding 3 mg/L would increase from 52% under existing conditions to 74% under the Alternative 4 LLT (an increase from 47% to 70% for the drought period), and concentrations exceeding 4 mg/L would increase from 30% to 36% (32% to 38% for the drought period). For Contra Costa PP No. 1, long-term average DOC concentrations exceeding 3 mg/L would increase from 52% under existing conditions to 80% under Alternative 4 LLT (45% to 80% for the drought period), and concentrations exceeding 4 mg/L would increase from 32% to 41% (35% to 42% for the drought period). Relative change in frequency of threshold exceedance for other assessment locations would be similar or less. While Alternative 4 LLT would generally lead to slightly higher long-term average DOC concentrations (≤0.4 mg/L) at some municipal water intakes and Delta interior locations, the predicted change would not be expected to adversely affect MUN beneficial uses, or any other beneficial use.

In comparison, Alternative 4 LLT relative to the No Action Alternative NT and No Action Alternative LLT would generally result in a similar magnitude of change to that discussed for the comparison to existing conditions. Maximum increases of 0.3- 0.4 mg/L DOC (i.e., ≤12%) would be predicted at Franks Tract, Rock Slough, and Contra Costa PP No. 1 relative to No Action Alternative NT, while maximum increases at these locations would be slightly less (i.e., between 0.2-0.3 mg/L) when compared to No Action Alternative LLT (Appendix 8K, DOC Table 5). Threshold concentration exceedance frequency trends would also be similar to that discussed for the existing condition comparison, with exception to the predicted 4 mg/L exceedance frequency at Buckley Cove. In comparison to the No Action Alternative NT, the frequency which long-term average DOC concentrations exceeded 4 mg/L at Buckley Cove would increase from 23% to 28% (37% to 50% for the modeled drought period), with slightly smaller increases when comparing to No Action Alternative LLT. While the Alternative 4 LLT would generally lead to slightly higher long-term average DOC concentrations at some Delta assessment locations when compared to No Action Alternative NT and No Action Alternative LLT conditions, the predicted change would not be expected to adversely affect MUN beneficial uses, or any other beneficial use, particularly when considering the relatively small change in long-term annual average concentration.

As discussed for Alternative 1A, substantial change in ambient DOC concentrations would need to occur before significant changes in drinking water treatment plant design or operations are triggered. The increases in long-term average DOC concentrations estimated to occur at various Delta locations under Alternative 4 are of sufficiently small magnitude that they will not require existing drinking water treatment plants to substantially upgrade treatment for DOC removal above levels currently employed.

Relative to existing, No Action Alternative NT, and No Action Alternative LLT conditions, Alternative 4 LLT would lead to predicted improvements in long-term average DOC concentrations at Barker Slough, Banks and Jones pumping plants. At these locations, long-term average DOC concentrations would be predicted to decrease by as much as <0.1 - 0.5 mg/L, depending on baseline comparison.

SWP/CVP Export Service Areas

Under Alternative 4 LLT, modeled long-term average DOC concentrations would decrease at Banks and Jones pumping plants for both the modeled 16-year hydrologic period and the modeled drought period, relative to existing conditions, No Action Alternative NT, and No Action Alternative LLT. Relative to existing conditions, long-term average DOC concentrations at Banks would be predicted to decrease by 0.5 mg/L (0.2 mg/L during drought period) (Appendix 8K, DOC Table 5). At Jones, long-term average DOC concentrations would be predicted to decrease by 0.4 mg/L (<0.1 mg/L during drought period). Such decreases in long-term average DOC would result in generally lower exceedance frequencies for concentration thresholds, although the frequency of exceedance during the modeled drought period (i.e., 1987-1991) would be predicted to increase. For the Banks pumping plant during the drought period, exceedance of the 3 mg/L threshold would increase from 57% under existing conditions to 84% under Alternative 4 LLT, but exceedance of the 4 mg/L concentration threshold would decrease slightly. At the Jones pumping plant, exceedance of the 3 mg/L concentration threshold during the drought period would increase from 72% under existing conditions to 88% under Alternative 4 LLT, but unlike at Banks, exceedance of the 4 mg/L threshold would increase from 35% to 42%. Comparisons to No Action Alternative NT and No Action Alternative LLT yield similar trends, but with slightly smaller magnitude drought period changes. Overall, modeling results for the SWP/CVP Export Service Areas predict an overall improvement in Export Service Areas water quality, although more frequent exports of >3mg/L DOC water would likely occur for drought periods.

Similar to the discussion pertaining to the No Action Alternative LLT, maintenance of SWP and CVP facilities under Alternative 4 LLT would not be expected to create new sources of DOC or contribute towards a substantial change in existing sources of DOC in the affected area. Maintenance activities would not be expected to cause any substantial change in long-term average DOC concentrations such that MUN beneficial uses, or any other beneficial use, would be adversely affected.

***CEQA Conclusion*:** Relative to existing conditions, Alternative 4 LLT operation and maintenance would not result in any substantial change in long-term average DOC concentration upstream of the Delta or result in substantial increase in the frequency with which long-term average DOC concentrations exceeds 2, 3, or 4 mg/L levels at the 11 assessment locations analyzed for the Delta. Modeled long-term average DOC concentrations would increase by no more than 0.4 mg/L at any single Delta assessment location (i.e., ≤12% relative increase), with long-term average concentrations estimated to remain at or below 4.0 mg/L at all Delta locations assessed, with the exception of Buckley Cove on the San Joaquin River during the drought period modeled. Nevertheless, long-term average concentrations at Buckley Cove are expected to decrease slightly during the drought period, relative to existing conditions. The increases in long-term average DOC concentration that could occur within the Delta would not be of sufficient magnitude to adversely affect the MUN beneficial use, or any other beneficial uses, of Delta waters or waters of the SWP/CVP Service Area. Because DOC is not bioaccumulative, the increases in long-term average DOC concentrations would not directly cause bioaccumulative problems in aquatic life or humans. Finally, DOC is not causing beneficial use impairments and thus is not 303(d) listed for any water body within the affected environment. Thus, the increases in long-term average DOC that could occur at various locations would not make any beneficial use impairment measurably worse. Because long-term average DOC concentrations are not expected to increase substantially, no long-term water quality degradation with respect to DOC is expected to occur and, thus, no adverse effects on beneficial uses would occur This impact is considered to be less than significant. No mitigation is required.

Impact WQ-18: Effects on dissolved organic carbon concentrations resulting from implementation of CM2–CM22

Conservation components proposed under Alternative 4 would be the same as those proposed under Alternative 1A. As such, effects on DOC resulting from the implementation of CM2-CM22 would be similar to that previously discussed for Alternative 1A LLT. In summary, conservation measures CM4-CM7 and CM10 could contribute substantial amounts of DOC to raw drinking water supplies, largely depending on final design and operational criteria for the related wetland and riparian habitat restoration activities. Substantially increased long-term average DOC in raw water supplies could lead to a need for treatment plant upgrades in order to appropriately manage DBP formation in treated drinking water. This potential for future DOC increases would lead to substantially greater associated risk of long-term adverse effects on the MUN beneficial use.

CEQA Conclusion: Effects of CM4-CM7 and CM10 on DOC under Alternative 4 LLT would be similar to those discussed for Alternative 1A LLT. Similar to the discussion for Alternative 1A, this impact is considered to be significant and mitigation is required. It is uncertain whether implementation of Mitigation Measure WQ-18 would reduce identified impacts to a less than significant level. Hence, this impact could remain significant after mitigation.

Mitigation Measure WQ-18: Design wetland and riparian habitat features to minimize effects on municipal intakes

Please see Mitigation Measure WQ-18 under Impact WQ-18 in the discussion of Alternative 1A.

Impact WQ-19: Effects on pathogens resulting from facilities operations and maintenance

Effects of CM1 on pathogens under Alternative 4 are the same as those discussed for Alternative 1A LLT. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-20: Effects on pathogens resulting from implementation of CM2–CM22

Effects of CM2–CM22on pathogens under Alternative 4 are the same as those discussed for Alternative 1A LLT. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-21: Effects on pesticide concentrations resulting from facilities operations and maintenance (CM1)

Upstream of the Delta

For the same reasons stated for the No Action Alternative LLT, under Alternative 4 LLT no specific operations or maintenance activity of the SWP or CVP would substantially drive a change in pesticide use, and thus pesticide sources would remain unaffected upstream of the Delta. Nevertheless, changes in the timing and magnitude of reservoir releases could have an effect on available dilution capacity along river segments such as the Sacramento, Feather, American, and San Joaquin Rivers.

Under Alternative 4 LLT, winter (November –March) and summer (April – October) season average flow rates on the Sacramento River at Freeport, American River at Nimbus, Feather River at Thermalito and the San Joaquin River at Vernalis would change. Relative to existing condition, No Action Alternative NT and No Action Alternative LLT, seasonal average flow rates on the Sacramento would decrease no more than 5% during the summer and 4% during the winter relative to existing conditions (Appendix 8L, Seasonal average flows Tables 1-4). On the Feather River, average flow rates would decrease no more than 2% during the summer and winter, while on the American River average flow rates would decrease by as much as 15% in the summer but would increase by as much as 9% in the winter. Seasonal average flow rates on the San Joaquin River would decrease by as much as 12% in the summer, but increase by as much as 3% in the winter. For the same reasons stated for the No Action Alternative LLT, decreased seasonal average flow of ≤15% is not considered to be of sufficient magnitude to substantially increase pesticide concentrations or alter the long-term risk of pesticide-related toxicity to aquatic life, nor adversely affect other beneficial uses of water bodies upstream of the Delta.

Delta

Sources of diuron, OP and pyrethroid insecticides to the Plan Area include direct input of surface runoff from in-Delta agriculture and Delta urbanized areas as well inputs from rivers upstream of the Delta. Similar to Upstream of the Delta, CVP/SWP operations would not affect these sources.

Under Alternative 4 LLT, the distribution and mixing of Delta source waters would change. Percent change in monthly average source water fraction were evaluated for the modeled 16-year (1976-1991) hydrologic period and a representative drought period (1987-1991), with special attention given to changes in San Joaquin River, Sacramento River and Delta Agriculture sources water fractions. Relative to existing conditions, under Alternative 4 LLT modeled San Joaquin River fractions would increase greater than 10% at Buckley Cove (drought period only), Franks Tract, Rock Slough, and Contra Costa PP No. 1 (Appendix 8D, Source Water Fingerprinting). At Buckley Cove, San Joaquin River source water fractions when modeled for the drought period would increase 16% in August. At Franks Tract, source water fractions when modeled for the 16-year hydrologic period would increase 13-17% during October through November and February through April. At Rock Slough, modeled San Joaquin River source water fractions would increase 11-24% during September through March (11-15% during October and November of the modeled drought period). Similarly, modeled San Joaquin River fractions at Contra Costa Pumping Plant No. 1 would increase 10-24% during October through April (11-13% during October and November of the modeled drought period). While the modeled 24% increases of San Joaquin River Fraction at Rock Slough and Contra Costa PP No. 1 in November are considerable, the resultant net fraction would be ≤30%. Relative to existing conditions, there would be no modeled increases in Sacramento River fractions greater than 13% (with exception to Banks and Jones, discussed below) and Delta agricultural fractions greater than 8%. These modeled changes in the source water fractions of Sacramento, San Joaquin and Delta agriculture water are not of sufficient magnitude to substantially alter the long-term risk of pesticide-related toxicity to aquatic life, nor adversely affect other beneficial uses of the Delta.

When compared to No Action Alternative NT and No Action Alternative LLT, changes in source water fractions would be similar in season, geographic extent, and magnitude to those discussed for existing conditions with exception to Buckley Cove. At Buckley Cove, modeled San Joaquin River fractions would increase 16% in July (33% for the modeled drought period) and 25% (48% for the modeled drought period) in August when compared to No Action Alternative LLT (Appendix 8D, Source Water Fingerprinting). These increases would primarily balance through decreases in Sacramento River water and eastside tributary waters, and as a result the San Joaquin River would account for as much as 75% of the total source water volume at Buckley Cove in July and August (as much as 60% for the modeled drought period). While the source water and potential pesticide related toxicity co-occurrence predictions do not mean adverse effect would occur, such considerable modeled increases in summer source water fraction at Buckley Cove could substantially alter the long-term risk of pesticide-related toxicity to aquatic life, given the apparent greater incidence of pesticides in the San Joaquin River.

These predicted adverse effects on pesticides relative to No Action Alternative LLT fundamentally assume that the present pattern of pesticide incidence in surface water will occur at similar levels into the future. In reality, however, the makeup and character of the pesticide use market in the late long-term (i.e., the year 2060) will not be exactly as it is today. Current use of chlorpyrifos and diazinon is on the decline with their replacement by pyrethroids on the rise, yet in this assessment it is the apparent greater incidence of diazinon and chlorpyrifos on the San Joaquin River that serves as the basis for concluding that substantially increased San Joaquin River source water fraction would correspond to an increased risk of pesticide-related toxicity to aquatic life. By 2060, however, alternatives pesticides, such as neonicitinoids and biologicals, will likely be a more substantial contributing part of the existing mix of pesticides, and perhaps more prominent. The trend in the development of future-use pesticides is towards reduced risk pesticides, including more biopesticides, with greater targeted specificity, fewer residues, and lower overall non-target toxicity. By 2060 existing chlorpyrifos and diazinon TMDLs for the Sacramento and San Joaquin Rivers will have been in effect for more than 50 years. Moreover, it is reasonable to expect that CWA section 303(d) listings and future additional listings will have developed TMDLs by 2060. To the extent these existing and future TMDL's address current and future-use pesticides, a greater degree of pesticide related source control can be anticipated. Nevertheless, forecasting whether these various efforts will ultimately be successful at resolving current pesticide related impairments requires considerable speculation. While the fundamental assumptions that have guided this assessment of pesticides may be somewhat altered by 2060, these assumptions are informed by actual studies and monitoring data collected from the recent past and, therefore, judging project alternative effects in the future remain most accurate through use of these informed assumptions rather than based on assumptions founded upon future speculative conditions.

SWP/CVP Export Service Areas

Assessment of effects in SWP/CVP Export Service Areas is based on effects seen in the Plan Area at the Banks and Jones pumping plants. Under Alternative 4 LLT, Sacramento River source water fractions would increase substantially at both Banks and Jones pumping plants relative to existing conditions, No Action Alternative NT and No Action Alternative LLT (Appendix 8D, Source Water Fingerprinting). At Banks pumping plant, Sacramento source water fractions would generally increase from 23-50% for the period of January through June (24-25% for March through April of the modeled drought period) and at Jones pumping plant Sacramento source water fractions would generally increase from 34-58% for the period of January through June (19-49% for February through May of the modeled drought period). These increases in Sacramento source water fraction would primarily balance through equivalent decreases in San Joaquin River water. Based on the general observation that San Joaquin River, in comparison to the Sacramento River, is a greater contributor of OP insecticides in terms of greater frequency of incidence and presence at concentrations exceeding water quality benchmarks, modeled increases in Sacramento River fraction at Banks and Jones would generally represent an improvement in export water quality respective to pesticides.

***CEQA Conclusion*:** Relative to existing conditions, the Alternative 4 LLT would not result in any substantial change in long-term average pesticide concentration or result in substantial increase in the anticipated frequency with which long-term average pesticide concentrations would exceed aquatic life toxicity thresholds or other beneficial use effect thresholds upstream of the Delta, at the 11 assessment locations analyzed for the Delta, or the SWP/CVP service area. Numerous pesticides are currently used throughout the affected environment, and while some of these pesticides may be bioaccumulative, those present-use pesticides for which there is sufficient evidence for their presence in waters affected by SWP and CVP operations (i.e., diazinon, chlorpyrifos, diuron, and pyrethroids) are not considered bioaccumulative, and thus changes in their concentrations would not directly cause bioaccumulative problems in aquatic life or humans. Furthermore, while there are numerous 303(d) listings throughout the affected environment that name pesticides as the cause for beneficial use impairment, the modeled changes in upstream river flows and Delta source water fractions would not be expected to make any of these beneficial use impairments measurably worse.

Because long-term average pesticide concentrations are not expected to increase substantially, no long-term water quality degradation with respect to pesticides is expected to occur and, thus, no adverse effects on beneficial uses would occur. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-22: Effects on pesticide concentrations resulting from implementation of CM2–CM22

Conservation components proposed under Alternative 4 would be the same as those proposed under Alternative 1A. As such, effects on pesticides resulting from the implementation of CM2–CM22would be similar to that previously discussed for Alternative 1A LLT. In summary, CM13 proposes the use of herbicides to control invasive aquatic vegetation around habitat restoration sites. Herbicides directly applied to water could include adverse effects on non-target aquatic life, such as aquatic invertebrates and beneficial aquatic plants. As such, aquatic life toxicity objectives could be exceeded with sufficient frequency and magnitude such that beneficial uses would be impacted.

***CEQA Conclusion*:** Effects of CM2–CM22on pesticides under Alternative 4 LLT are the similar as those discussed for Alternative 1A LLT. Potential environmental effects related only to CM13 are considered to be significant. Mitigation is required. While Mitigation Measure WQ-22 is available to partially reduce this impact of pesticides, no feasible mitigation is available that would reduce it to a level that would be less than significant.

Mitigation Measure WQ-22: Implement least toxic integrated pest management strategies

Please see Mitigation Measure WQ-22 under Impact WQ-22 in the discussion of Alternative 1A.

Impact WQ-23: Effects on phosphorus concentrations resulting from facilities operations and maintenance (CM1)

Effects of water facilities and operations (CM1) on phosphorus levels in water bodies of the affected environment under Alternative 3 LLT would be very similar (i.e., nearly the same) as those discussed for Alternative 1A LLT. Consequently, the environmental consequences to phosphorus levels discussed in detail for Alternative 1A LLT also adequately represent the effects under Alternative 3 LLT. Based on this finding, this impact is considered to be less than significant. No mitigation is required.

Impact WQ-24: Effects on phosphorus concentrations resulting from implementation of CM2–CM22

Effects of CM2–23 on phosphorus levels in water bodies of the affected environment under Alternative 4 LLT would be very similar (i.e., nearly the same) as those discussed for Alternative 1A LLT. Consequently, the environmental consequences to phosphorus levels from implementing CM2-CM22 discussed in detail for Alternative 1A LLT also adequately represent the effects of these same actions under Alternative 4 LLT. Based on this finding, this impact is considered to be less than significant. No mitigation is required.

Impact WQ-25: Effects on selenium concentrations resulting from facilities operations and maintenance (CM1)

[*Note to Lead Agencies: This assessment is in preparation*].

Impact WQ-26: Effects on selenium concentrations resulting from implementation of CM2–CM22

[*Note to Lead Agencies: This assessment is in preparation*].

Impact WQ-27: Effects on trace metal concentrations resulting from facilities operations and maintenance (CM1)

Upstream of the Delta

For the same reasons stated for the No Action Alternative LLT, Alternative 4 LLT would result in negligible, and likely immeasurable, increases in trace metal concentrations in the rivers and reservoirs upstream of the Delta, relative to existing conditions, No Action NT and No Action LLT. Effects due to the operation and maintenance of the conveyance facilities are expected to be immeasurable, on an annual and long-term average basis. As such, the Alternative 4 would not be expected to substantially increase the frequency with which applicable Basin Plan objectives or CTR criteria would be exceeded in water bodies of the affected environment located upstream of the Delta or substantially degrade the quality of these water bodies, with regard to trace metals.

Delta

For the same reasons stated for the No Action Alternative LLT, Alternative 4 LLT would not result in substantial increases in trace metal concentrations in the Delta relative to existing conditions, No Action NT, and No Action LLT. Effects due to the operation and maintenance of the conveyance facilities are expected to be negligible, on long-term average basis. As such, Alternative 4 would not be expected to substantially increase the frequency with which applicable Basin Plan objectives or CTR criteria would be exceeded in the Delta or substantially degrade the quality of Delta waters, with regard to trace metals.

SWP/CVP Export Service Areas

For the same reasons stated for the No Action Alternative LLT, Alternative 4 LLT would not result in substantial increases in trace metal concentrations in the water exported from the Delta or diverted from the Sacramento River through the proposed conveyance facilities. As such, there is not expected to be substantial changes in trace metal concentrations in the SWP/CVP export service area waters under Alternative 4, relative to existing conditions, No Action NT, and No Action LLT. As such, Alternative 4 would not be expected to substantially increase the frequency with which applicable Basin Plan objectives or CTR criteria would be exceeded in the water bodies of the affected environment in the SWP and CVP Service Area or substantially degrade the quality of these water bodies, with regard to trace metals.

CEQA Conclusion: There would be no substantial long-term increase in trace metal concentrations in the rivers and reservoirs upstream of the Delta, in the Delta Region, or the SWP/CVP export service area waters under Alternative 4 relative to existing conditions. As such, this alternative is not expected to cause additional exceedance of applicable water quality objectives by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. Because trace metal concentrations are not expected to increase substantially, no long-term water quality degradation for trace metals is expected to occur and, thus, no adverse effects to beneficial uses would occur. Furthermore, any negligible changes in long-term trace metal concentrations that may occur in water bodies of the affected environment would not be expected to make any existing beneficial use impairments measurably worse. The trace metals discussed in this assessment are not considered bioaccumulative, and thus would not directly cause bioaccumulative problems in aquatic life or humans. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-28: Effects on trace metal concentrations resulting from implementation of CM2–CM22

Conservation components proposed under Alternative 4 would be the same as those proposed under Alternative 1A. As such, effects on trace metals resulting from the implementation of CM2-CM22 would be similar to that previously discussed for Alternative 1A. As they pertain to trace metals, implementation of CM2-CM22 would not be expected to adversely affect beneficial uses of the affected environment or substantially degrade water quality with respect to trace metals.

CEQA Conclusion: Implementation of CM2-CM22 under Alternative 4 would not cause substantial long-term increase in trace metal concentrations in the rivers and reservoirs upstream of the Delta, in the Delta Region, or the SWP/CVP export service area. As such, this alternative is not expected to cause additional exceedance of applicable water quality objectives by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. Because trace metal concentrations are not expected to increase substantially, no long-term water quality degradation for trace metals is expected to occur and, thus, no adverse effects to beneficial uses would occur. Furthermore, any negligible changes in long-term trace metal concentrations that may occur throughout the affected environment would not be expected to make any existing beneficial use impairments measurably worse. The trace metals discussed in this assessment are not considered bioaccumulative, and thus would not directly cause bioaccumulative problems in aquatic life or humans. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-29: Effects on TSS and turbidity resulting from facilities operations and maintenance (CM1)

Effects of CM1 on TSS and turbidity under Alternative 4 are the same as those discussed for Alternative 1A LLT. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-30: Effects on TSS and turbidity resulting from implementation of CM2–CM22

Effects of CM2–CM22on TSS and turbidity under Alternative 4 are the same as those discussed for Alternative 1A LLT. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-31: Water quality effects resulting from construction-related activities

The conveyance features for CM1 under Alternative 4 would be very similar to those discussed for Alternative 1A. The primary difference between Alternative 4 and Alternative 1A is that under Alternative 4, the fewer number of intakes would result in a reduced level of construction activity. However, construction techniques and locations of major features of the conveyance system within the Delta would be similar. The remainder of the facilities constructed under Alternative 4, including conservation measures CM2-CM22, would be very similar to, or the same as, those to be constructed for Alternative 1A.

The types and magnitude of potential construction-related water quality effects associated with implementation of conservation measures CM1-CM22 under Alternative 4 would be very similar to the effects discussed for Alternative 1A LLT, and the effects anticipated with implementation of CM2-CM22 would be essentially identical. Nevertheless, the construction of CM1 with the environmental commitments and agency permitted construction requirements and BMPs would result in the potential water quality effects being largely avoided and minimized. The specific environmental commitments that would be implemented under Alternative 4 would be similar to those described for Alternative 1A. Consequently, relative to existing conditions, Alternative 4 LLT would not be expected to cause exceedance of applicable water quality objectives/criteria or substantial water quality degradation with respect to constituents of concern, and thus would not adversely affect any beneficial uses upstream of the Delta, in the Delta, or in the SWP and CVP service area.

***CEQA Conclusion*:** Construction-related contaminant discharges would be temporary and intermittent in nature and would involve negligible, if any, discharges of bioaccumulative or 303(d) listed constituents to water bodies of the affected environment. As such, construction activities would not contribute measurably to bioaccumulation of contaminants in organisms or humans or cause 303(d) impairments to be discernibly worse. Because environmental commitments would be implemented under Alternative 4 LLT for construction-related activities along with agency-issues permits that also contain construction requirements to protect water quality, the construction-related effects would not be expected to cause or contribute to a substantial increased frequency of exceedances of water quality objectives/criteria relative to existing conditions, or substantially degrade water quality with respect to the constituents of concern on a long-term average basis, and thus would not adversely affect any beneficial uses in water bodies upstream of the Delta, within the Delta, or in the SWP and CVP service area. Based on these findings, this impact is determined to be less than significant. No mitigation is required.

8.3.4.8 Alternative 5—Dual Conveyance with Tunnel and Intake (3,000 cfs; Operational Scenario C)

Alternative 5 would convey up to 3,000 cfs of water from the north Delta to the south Delta through pipelines/tunnels from one screened intake on the east bank of the Sacramento River between Clarksburg and Walnut Grove. A new Byron Tract Forebay, adjacent to and south of Clifton Court Forebay, would be constructed which would provide water to the south Delta pumping plants. Water supply and conveyance operations would follow the guidelines described as Scenario C, which includes fall X2. Conservation measures 2-23 (CM2-23) would be implemented under this alternative, and would be the same as those under Alternative 1A with the exception of CM 4, which would involve 25,000 acres of tidal habitat restoration instead of 65,000 acres under the other action alternatives. See Chapter 3, *Description of Alternatives*, for additional details on Alternative 5.

Impact WQ-1: Effects on ammonia concentrations resulting from facilities operations and maintenance (CM1)

Upstream of the Delta

For the same reasons stated for the No Action Alternative LLT, Alternative 5 LLT would have negligible, if any, effect on ammonia concentrations in the rivers and reservoirs upstream of the Delta relative to existing conditions and the No Action Alternative NT and LLT. Any negligible increases in ammonia-N concentrations that could occur in the water bodies of the affected environment located upstream of the Delta would not be of frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the quality of these water bodies, with regard to ammonia.

Delta

Assessment of effects of ammonia under Alternative 5 LLT is the same as discussed under Alternative 1A, except that because flows in the Sacramento River at Freeport are different between the two alternatives, estimated monthly average and long term annual average predicted ammonia-N concentrations in the Sacramento River downstream of Freeport are different.

As Table 8-58 shows, estimated ammonia-N concentrations in the Sacramento River downstream of Freeport (upon full mixing of the SRWTP discharge with river water) under Alternative 5 LLT and the No Action Alternative LLT are expected to be similar. Minor increases in ammonia-N concentrations would occur during July through September, November hrough January, and in April, and remaining months would be unchanged or have a minor decrease. Annual average concentrations would be the same under both Alternative 5 LLT and the No Action Alternative LLT. Moreover, the estimated concentrations downstream of Freeport under Alternative 5 LLT would be similar to existing source water concentrations for the San Francisco Bay and San Joaquin River. Consequently, changes in source water fraction anticipated under Alternative 5 LLT, relative to the No Action Alternative LLT, are not expected to substantially increase ammonia concentrations at any Delta locations.

Table 8-58. Estimated Ammonia-N (mg-L as N) Concentrations in the Sacramento River Downstream of the Sacramento Regional Wastewaster Treatment Plant for the No Action Alternative LLT and Alternative 5 LLT

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual Average
No Action Alternative LLT	0.081	0.073	0.061	0.055	0.053	0.055	0.061	0.070	0.072	0.064	0.072	0.069	0.063
Alternative 5 LLT	0.079	0.076	0.062	0.056	0.053	0.055	0.062	0.069	0.069	0.065	0.076	0.072	0.063

Any negligible increases in ammonia-N concentrations that could occur at certain locations in the Delta would not be of frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the water quality at these locations, with regards to ammonia.

SWP/CVP Export Service Areas

The assessment of effects on ammonia in the SWP/CVP Export Service Area is based on assessment of ammonia-N concentrations at Banks and Jones pumping plants. Similar to the discussion for Alternative 1A, under Alternative 5 for areas of the Delta that are influenced by Sacramento River water, including Banks and Jones pumping plants, ammonia-N concentrations are expected to decrease, relative to existing conditions and No Action Alternative NT. This decrease in ammonia-N concentrations for water exported via the south Delta pumps is not expected to result in an adverse effects on beneficial uses or substantially degrade water quality of exported water, with regards to ammonia.

Furthermore, as discussed above for the PlanArea, for all areas of the Delta, including Banks and Jones pumping plants, ammonia-N concentrations are not expected to be substantially different under Alternative 5 LLT, relative to No Action Alternative LLT. Any negligible increases in ammonia-N concentrations that could occur at Banks and Jones pumping plants would not be of frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the water quality at these locations, with regards to ammonia.

***CEQA Conclusion*:** There would be no substantial, long-term increase in ammonia-N concentrations in the rivers and reservoirs upstream of the Delta, in the Plan Area, or the waters exported to the CVP and SWP service areas under Alternative 5 LLT relative to existing conditions. As such, this alternative is not expected to cause additional exceedance of applicable water quality objectives/criteria by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. Because ammonia concentrations are not expected to increase substantially, no long-term water quality degradation is expected to occur and, thus, no adverse effects on beneficial uses would occur. Ammonia is not 303(d) listed within the affected environment and thus any minor increases than could occur in some areas would not make any existing ammonia-related impairment measurably worse because no such impairments currently exist. Because ammonia-N is not bioaccumulative, minor increases that could occur in some areas would not bioaccumulate to greater levels in aquatic organisms that would, in turn, pose substantial health risks to fish, wildlife, or humans. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-2: Effects on ammonia concentrations resulting from implementation of CM2–CM22

Effects of CM2–CM22on ammonia under Alternative 5 LLT are the same as those discussed for Alternative 1A LLT. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-3:Effects on boron concentrations resulting from facilities operations and maintenance (CM1)

Upstream of the Delta

Effects of CM1 on boron under Alternative 5A LLT in areas upstream of the Delta would be very similar to the effects discussed for Alternative 1A LLT. There would be no expected change to the sources of boron in the Sacramento and east-side tributary watersheds, and resultant changes in flows from altered system-wide operations would have negligible, if any, effects on the concentration of boron in the rivers and reservoirs of these watersheds. The modeled long-term annual average lower San Joaquin River flow at Vernalis would decrease slightly compared to existing conditions and the No Action Alternative NT, and would be similar compared to the No Action Alternative LLT. The reduced flow would result in possible increases in long-term average boron concentrations of up to about 3% relative to the existing conditions and No Action Alternative NT conditions. The increased boron concentrations would not increase the frequency of exceedances of any applicable objectives or criteria and would not be expected to cause further degradation at measurable levels in the lower San Joaquin River, and thus would not cause the existing impairment there to be discernibly worse. Consequently, Alternative 5A LLT would not be expected to cause exceedance of boron objectives/criteria or substantially degrade water quality with respect to boron, and thus would not adversely affect any beneficial uses of the Sacramento River, the east-side tributaries, associated reservoirs upstream of the Delta, or the San Joaquin River.

Delta

Effects of CM1 on boron under Alternative 5A LLT in the Delta would be very similar to the effects discussed for Alternative 1A LLT. Relative to the existing conditions, No Action Alternative NT, and No Action Alternative LLT, Alternative 5A LLT would result in increased long-term average boron concentrations for the 16-year period modeled at interior and western Delta locations (by as much as 7% at the SF Mokelumne River at Staten Island, 2% at the San Joaquin River at Buckley Cove, 8% at Franks Tract, 8% at Old River at Rock Slough, and 3% at the Sacramento River at Emmaton) (Appendix 8F, Table Bo-14). Implementation of tidal habitat restoration under conservation measure CM4 also may contribute to increased boron concentrations at western Delta assessment locations, and thus would not be anticipated to substantially affect agricultural diversions which occur primarily at interior Delta locations. The long-term annual average and monthly average boron concentrations, for either the 16-year period or drought period modeled, would never exceed the 2,000 μg/L human health advisory objective (i.e., for children) or 500 μg/L agricultural objective at any of the eleven Delta assessment locations, which represents no change from the existing conditions and No Action Alternative NT and LLT conditions (Appendix 8F, Table Bo-3). Reductions in long-term average assimilative capacity of up to 4% at interior Delta locations (i.e., Franks Tract and Old River at Rock Slough) would be small with respect to the 500 μg/L agricultural objective (Appendix 8F, Table Bo-15). However, because the absolute boron concentrations would still be well below the lowest 500 μg/L objective for the protection of the agricultural beneficial use under Alternative 5A LLT, the levels of boron degradation would not be of sufficient magnitude to substantially increase the risk of exceeding objectives or cause adverse effects to municipal and agricultural water supply beneficial uses, or any other beneficial uses, in the Delta (Appendix 8F, Figure Bo-3).

SWP/CVP Export Service Areas

Effects of CM1 on boron under Alternative 5A LLT in the Delta would be very similar to the effects discussed for Alternative 1A LLT. Under Alternative 5A LLT, long-term average boron concentrations would decrease by as much as 25% at the Banks Pumping Plant and by as much 27% at Jones Pumping Plant relative to existing conditions, No Action Alternative NT, and No Action Alternative LLT (Appendix 8F, Table Bo-14). Commensurate with the decrease in exported boron concentrations, boron concentrations in the lower San Joaquin River may be reduced and would likely alleviate or lessen any expected increase in boron concentrations at Vernalis associated with flow reductions (see discussion of Upstream of the Delta), as well locations in the Delta receiving a large fraction of San Joaquin River water. Reduced export boron concentrations also may contribute to reducing the existing 303(d) impairment in the lower San Joaquin River and associated TMDL actions for reducing boron loading.

Maintenance of SWP and CVP facilities under Alternative 5A LLT would not be expected to create new sources of boron or contribute towards a substantial change in existing sources of boron in the affected environment. Maintenance activities would not be expected to cause any substantial increases in boron concentrations or degradation with respect to boron such that objectives would be exceeded more frequently, or any beneficial uses would be adversely affected anywhere in the affected environment.

CEQA Conclusion: Boron is not a bioaccumulative constituent, thus any increased concentrations under Alternative 5A LLT would not result in adverse boron bioaccumulation effects to aquatic life or humans. Relative to existing conditions, Alternative 5A LLT would not result in any substantial increases in boron concentration upstream of the Delta. Alternative 5A LLT maintenance also would not result in any substantial increases in boron concentrations in the affected environment. Relative to existing conditions, Alternative 5A LLT would not result in substantially increased boron concentrations such that frequency of exceedances of municipal and agricultural water supply objectives would increase. The levels of boron degradation that may occur under Alternative 5A LLT would not be of sufficient magnitude to cause substantially increased risk for adverse effects to municipal or agricultural beneficial uses within the affected environment. Long-term average boron concentrations would decrease in Delta water exports to the SWP and CVP service area, which may contribute to reducing the existing 303(d) impairment of agricultural beneficial uses in the lower San Joaquin River. Based on these findings, this impact is determined to be less than significant. No mitigation is required.

Impact WQ-4: Effects on boron concentrations resulting from implementation of CM2–CM22

Effects of CM2-CM22 on boron under Alternative 5A LLT are the same as those discussed for Alternative 1A LLT. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-5: Effects on bromide concentrations resulting from facilities operations and maintenance (CM1)

Upstream of the Delta

Under Alternative 5 LLT there would be no expected change to the sources of bromide in the Sacramento and eastside tributary watersheds. Bromide loading in these watersheds would remain unchanged and resultant changes in flows form altered system-wide operations under Alternative 5 LLT would have negligible, if any, effects on the concentration of bromide in the rivers and reservoirs of these watersheds. Consequently, Alternative 5 LLT would not be expected to adversely affect the MUN beneficial use, or any other beneficial uses, of the Sacramento River, the eastside tributaries, or their associated reservoirs upstream of the Delta.

Under Alternative 5 LLT, modeling indicates that long-term annual average flows on the San Joaquin River would decrease by 6%, relative to existing conditions, 5% relative to No Action Alternative NT, and would remain virtually the same relative to No Action Alternative LLT. Similar to the No Action Alternative LLT, these decreases in flow would result in possible increase in long-term average bromide concentrations of about 3%, relative to existing conditions, 2% relative to No Action Alternative NT, and less than <1% relative to No Action Alternative LLT. The small increases in lower San Joaquin River bromide levels that could occur under Alternative 5 LLT, relative to existing, No Action Alternative NT, and No Action Alternative LLT conditions would not be expected to adversely affect the MUN beneficial use, or any other beneficial uses, of the lower San Joaquin River.

Delta

Under Alternative 5 LLT, the geographic extent of effects pertaining to long-term average bromide concentrations in the Delta would be similar to that previously described for Alternative 1A LLT, although the magnitude of predicted long-term change and relative frequency of concentration threshold exceedances would be different. Relative to existing conditions, modeled long-term average bromide concentrations would increase at Staten Island, Emmaton, and Barker Slough, while modeled long-term average bromide concentrations would decrease at the other assessment locations (Appendix 8E, Bromide Table 12-13). Overall effects would be greatest at Barker Slough, where predicted long-term average bromide concentrations would increase from 51 µg/L to 63 µg/L (23% relative increase) for the modeled 16-year hydrologic period and would increase from 54 µg/L to 98 µg/L (84% relative increase) for the modeled drought period. At Barker Slough, the predicted 50 µg/L exceedance frequency would decrease from 49% under existing conditions to 38% under Alternative 5 LLT, but would increase from 55% to 68% during the drought period. At Barker Slough, the predicted 100 µg/L exceedance frequency would increase from 0% under existing conditions to 18% under Alternative 5 LLT, and would increase from 0% to 38% during the drought period. In contrast, increases in bromide at Staten Island would result in a 50 µg/L bromide threshold exceedance increase from 47% under existing conditions to 67% under Alternative 5 LLT (52% to 77% during the modeled drought period). However, unlike Barker Slough, modeling shows that long-term average bromide concentration at Staten Island would exceed the 100 µg/L assessment threshold concentration 1% under existing conditions and 2% under Alternative 5 LLT (0% to 2% during the modeled drought period). The long-term average bromide concentrations would be 59 µg/L (62 µg/L for the modeled drought period) at Staten Island under Alternative 5 LLT. Changes in exceedance frequency of the 50 µg/L and 100 µg/L concentration thresholds, as well as relative change in long-term average concentration, at other assessment locations would be less substantial.

Due to the relatively small differences between modeled existing conditions and No Action baselines, changes in long-term average bromide concentrations and changes in exceedance frequencies relative to No Action Alternative NT and No Action Alternative LLT are generally of similar magnitude to those previously described for the existing condition comparison (Appendix 8E, Bromide Table 12-13). Modeled long-term average bromide concentration increases would similarly be greatest at Barker Slough, where long-term average concentrations are predicted to increase by 29% (87% for the modeled drought period) relative to No Action Alternative NT, and would increase by 27% (83% for the modeled drought period) relative to No Action Alternative LLT. However, unlike the existing conditions comparison, long-term average bromide concentrations at Buckley Cove, Rock Slough, and Contra Costa PP No. 1 would increase relative to No Action Alternative NT and No Action Alternative LLT, although the increases would be relatively small (≤4%).

The increase in long-term average bromide concentrations predicted at Barker Slough, principally the relative increase in 100 µg/L exceedance frequency, would result in a substantial change in source water quality for existing drinking water treatment plants drawing water from the North Bay Aqueduct. As discussed for Alternative 1A, drinking water treatment plants obtaining water via the North Bay Aqueduct utilize a variety of conventional and enhanced treatment technologies in order to achieve DBP drinking water criteria. While the implications of such a modeled change in bromide at Barker Slough are difficult to predict, the substantial modeled increases could lead to adverse changes in the formation of disinfection byproducts such that considerable treatment plant upgrades may be necessary in order to achieve equivalent levels of health protection.

The seasonal intakes at Mallard Slough and City of Antioch are infrequently used due to water quality constraints related to sea water intrusion. On a long-term average basis, bromide at these locations is in excess of 3,000 µg/L, but during seasonal periods of high Delta outflow can be <300 µg/L. Use of the seasonal intakes at Mallard Slough and City of Antioch under Alternative 5 LLT would experience a period average increase in bromide during the months when these intakes would most likely be utilized. For those wet and above normal water year types where mass balance modeling would predict water quality typically suitable for diversion, predicted long-term average bromide would increase from 103 µg/L to 128 µg/L (25% increase) at City of Antioch and would increase from 150 µg/L to 194 µg/L (30% increase) at Mallard Slough relative to existing conditions (Appendix 8E, Bromide Figure 4-5). Increases would be similar for No Action Alternative NT and No Action Alternative LLT comparison. The decisions surrounding the use of these seasonal intakes is largely driven by acceptable water quality, and thus have historically been opportunistic. Opportunity to use these intakes would remain, and the predicted increases in bromide concentrations at the City of Antioch and Mallard Slough intake would not be expected to adversely affect MUN beneficial uses, or any other beneficial use, at these locations.

SWP/CVP Export Service Areas

Under Alternative 5 LLT, improvement in long-term average bromide concentrations would occur at the Banks and Jones pumping plants. Long-term average bromide concentrations for the modeled 16-year hydrologic period at these locations would decrease by as much as 30% relative to existing conditions, 22% relative to No Action Alternative NT, and 20% relative to No Action Alternative LLT. Relative change in long-term average bromide concentration would be less during drought conditions (≤27%), but would still represent considerable improvement (Appendix 8E, Bromide Tables 12-13). As a result, less frequent bromide concentration exceedances of the 50 µg/L and 100 µg/L assessment thresholds would be predicted and an overall improvement in Export Service Areas water quality would be experienced respective to bromide. Commensurate with the decrease in exported bromide, an improvement in lower San Joaquin River bromide would also be observed since bromide in the lower San Joaquin River is principally related to irrigation water deliveries from the Delta. While the magnitude of this expected lower San Joaquin River improvement in bromide is difficult to predict, the relative decrease in overall loading of bromide to the Export Service Areas would likely alleviate or lessen any expected increase in bromide concentrations at Vernalis (see discussion of Upstream of the Delta) as well locations in the Delta receiving a large fraction of San Joaquin River water, such as much of the south Delta.

Similar to the discussion pertaining to the No Action Alternative LLT, maintenance of SWP and CVP facilities under Alternative 5 LLT would not be expected to create new sources of bromide or contribute towards a substantial change in existing sources of bromide in the affected environment. Maintenance activities would not be expected to cause any substantial change in bromide such that MUN beneficial uses, or any other beneficial use, would be adversely affected anywhere in the affected environment.

***CEQA Conclusion*:** Relative to existing conditions, Alternative 5 LLT operation and maintenance would not result in any substantial change in long-term average bromide concentration upstream of the Delta. Furthermore, under Alternative 5 LLT, water exported from the Delta to the SWP/CVP service area would be substantially improved relative to bromide. Bromide is not bioaccumulative, therefore change in long-term average bromide concentrations would not directly cause bioaccumulative problems in aquatic life or humans. Additionally, bromide is not a constituent related to any 303(d) listings. Alternative 5 LLT operation and maintenance activities would not cause substantial long-term degradation to water quality respective to bromide with the exception of water quality at Barker Slough, source of the North Bay Aqueduct. At Barker Slough, modeled long-term annual average concentrations of bromide would increase by 23%, and 84% during the modeled drought period. For the modeled 16-year hydrologic period the frequency of predicted bromide concentrations exceeding 100 µg/L would increase from 0% under existing conditions to 18% under Alternative 5 LLT, while for the modeled drought period, the frequency would increase from 0% to 38%. Substantial changes in long-term average bromide could necessitate changes in treatment plant operation or require treatment plant upgrades in order to maintain DBP compliance. The model predicted change at Barker Slough is substantial and, therefore, would represent a substantially increased risk for adverse effects on existing MUN beneficial uses should treatment upgrades not be undertaken. The impact is considered significant and mitigation is required. Implementation of Mitigation Measure WQ-5 would reduce identified impacts to a less than significant level by relocating the North Bay Aqueduct outside the influence of sea water intrusion.

Mitigation Measure WQ-5: Move the North Bay Aqueduct intake from Barker Slough to the Sacramento River

Please see Mitigation Measure WQ-5 under Impact WQ-5 in the discussion of Alternative 1A.

Impact WQ-6: Effects on bromide concentrations resulting from implementation of CM2–CM22

Conservation components proposed under Alternative 5 LLT would be the same as those proposed under Alternative 1A LLT, except that 25,000 rather than 65,000 acres of tidal habitat would be restored. As discussed for Alternative 1A LLT, implementation of the CM2-CM22 would not present new or substantially changed sources of bromide to the project area. Some conservation measures may replace or substitute for existing irrigated agriculture in the Delta. This replacement or substitution is not expected to substantially increase or present new sources of bromide. CM2-CM22 would not be expected to cause any substantial change in bromide such that MUN beneficial uses, or any other beneficial use, would be adversely affected anywhere in the affected environment.

CEQA Conclusion: Conservation components proposed under Alternative 5 LLT would be similar to those proposed under Alternative 1A LLT, except that 25,000 rather than 65,000 acres of tidal habitat would be restored. As discussed for Alternative 1A LLT, implementation of the CM2-CM22 (CM2-CM22) would not present new or substantially changed sources of bromide to the project area. As such, effects on bromide resulting from the implementation of CM2-CM22 would be similar to that previously discussed for Alternative 1A LLT. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-7: Effects on chloride concentrations resulting from facilities operations and maintenance (CM1)

Upstream of the Delta

Under Alternative 5A LLT there would be no expected change to the sources of chloride in the Sacramento and eastside tributary watersheds. Chloride loading in these watersheds would remain unchanged and resultant changes in flows from altered system-wide operations would have negligible, if any, effects on the concentration of chloride in the rivers and reservoirs of these watersheds. The modeled long-term annual average flows on the lower San Joaquin River at Vernalis would decrease slightly compared to existing conditions and the No Action Alternative NT, and be similar compared to the No Action Alternative LLT. The reduced flow would result in possible increases in long-term average chloride concentrations of about 2%, relative to the existing conditions and No Action Alternative NT conditions, and no change relative to No Action Alternative LLT. Consequently, Alternative 5A LLT would not be expected to cause exceedance of chloride objectives/criteria or substantially degrade water quality with respect to chloride, and thus would not adversely affect any beneficial uses of the Sacramento River, the eastside tributaries, associated reservoirs upstream of the Delta, or the San Joaquin River.

Delta

Relative to existing conditions, Alternative 5A LLT would result in similar or reduced long-term average chloride concentrations for the 16-year period modeled at nine of the assessment locations, and increased concentrations at the North Bay Aqueduct at Barker Slough (up 18%), Sacramento River at Emmaton (up 1%), and San Joaquin River at Staten Island (up 16%) (Appendix 8G, Chloride Table Cl-21). Additionally, implementation of tidal habitat restoration under conservation measure CM4 would increase the tidal exchange volume in the Delta, and thus may contribute to increased chloride concentrations in the Bay source water as a result of increased salinity intrusion. Consequently, while uncertain, the magnitude of chloride increases may be greater than indicated herein and would affect the western Delta assessment locations the most which are influenced to the greatest extent by the Bay source water. The following outlines the modeled chloride changes relative to the applicable objectives and beneficial uses of Delta waters.

Municipal Beneficial Uses

Relative to the 150 mg/L Bay-Delta WQCP objective for municipal and industrial beneficial uses, the plots of monthly average chloride concentrations at the Contra Costa Canal at Pumping Plant #1 for the separate water year types indicates that the number of months above the objective would remain unchanged or decrease compared to the existing conditions (Appendix 8G, Figure Cl-6). The modeled chloride concentrations at the San Joaquin River at Antioch location would never meet this objective; however, this represents no change from the existing conditions.

With respect to the 250 mg/L Bay-Delta WQCP objective, the modeled frequency of exceedances based on monthly average chloride concentrations would decrease at the Contra Costa Canal at Pumping Plant #1 (Appendix 8G, Table Cl-22 and Figure Cl-7). The frequency of exceedances would increase for the 16-year period modeled at the San Joaquin River at Antioch (i.e., from 66% under existing conditions to 72%) and Sacramento River at Mallard Island (i.e., from 85% under existing conditions to 87%) (Appendix 8G, Table Cl-22), and would cause further degradation at Antioch in March and April (i.e., maximum reduction of 45% of assimilative capacity for the 16-year period modeled, and 100% reduction, or elimination of assimilative capacity, during the drought period modeled) (Appendix 8G, Table Cl-23 and Figure Cl-7). Based on the additional seasonal exceedances of the municipal objective and magnitude of long-term average water quality degradation with respect to chloride in the western Delta, the potential exists for substantial adverse effects on the municipal and industrial beneficial uses through reduced opportunity for diversion of water with acceptable salinity.

Aquatic Life Beneficial Uses

Relative to the 230 mg/L chronic EPA aquatic life criterion, monthly average chloride concentrations at the northern and eastern Delta locations would not exceed the criteria and the frequency of exceedances at most interior and southern Delta locations would decrease for the 16-year period modeled (Appendix 8G, Table Cl-22). Reductions in the modeled assimilative capacity at interior Delta locations (i.e., Franks Tract and Old River at Rock Slough) would occur during the January through June period when concentrations would be well below the criterion, and thus, would not adversely affect aquatic organisms (Appendix 8G, Table Cl-24 and Figure Cl-8).

303(d) Listed Water Bodies

With respect to the 303(d) listing for chloride in Tom Paine Slough, the monthly average chloride concentrations for the 16-year period modeled at Old River at Tracy Road would generally be similar compared to existing conditions, and thus, would not be further degraded on a long-term basis (Appendix 8G, Figure Cl-8). With respect to Suisun Marsh, the monthly average chloride concentrations for the 16-year period modeled would generally increase compared to existing conditions in some months during October through May at the Sacramento River at Collinsville (Appendix 8G, Figure Cl-9), Mallard Island (Appendix 8G, Figure Cl-7), and increase substantially at the Montezuma Slough at Beldon's Landing (i.e., over a doubling of concentration in December through February) (Appendix 8G, Figure Cl-10), thereby contributing to additional, measureable long-term degradation that potentially would adversely affect the necessary actions to reduce chloride loading for any TMDL that is developed.

Relative to the No Action Alternative NT and No Action Alternative LLT conditions, Alternative 4 LLT would result in similar or reduced long-term average chloride concentrations for the 16-year period modeled at eight of the assessment locations and increased concentrations at the SF Mokelumne River at Staten Island (up to 19%), Sacramento River at Emmaton (up to 10%), Sacramento River at Mallard Island (up to 3%), and the North Bay Aqueduct at Barker Slough (up to 23%) compared to the No Action Alternative NT or No Action Alternative LLT conditions (Appendix 8G, Table Cl-21). The modeled chloride changes relative to the applicable objectives and potential effects on beneficial uses are as follows.

SWP/CVP Export Service Areas

Under Alternative 5A LLT, long-term average chloride concentrations for the 16-year period modeled at the Banks and Jones pumping plants would decrease by as much as 29% relative to existing conditions, 22% relative to No Action Alternative NT, and 21% compared to No Action Alternative LLT (Appendix 8G, Chloride Table Cl-21). The modeled frequency of exceedances of applicable water quality objectives/criteria would decrease relative to existing conditions, No Action Alternative NT, and No Action Alternative LLT, for both the 16-year period and the drought period modeled (Appendix 8G, Chloride Table Cl-22). Consequently, water exported into the SWP/CVP service area would generally be of similar or better quality with regards to chloride relative to existing conditions and the No Action Alternative NT and No Action Alternative LLT conditions.

Commensurate with the reduced chloride concentrations in water exported to the service area, reduced chloride loading in the lower San Joaquin River would be anticipated which would likely alleviate or lessen any expected increase in chloride at Vernalis related to decreased annual average San Joaquin River flows (see discussion of Upstream of the Delta).

Maintenance of SWP and CVP facilities would not be expected to create new sources of chloride or contribute towards a substantial change in existing sources of chloride in the affected environment. Maintenance activities would not be expected to cause any substantial change in chloride such that any long-term water quality degradation would occur, thus, beneficial uses would not be adversely affected anywhere in the affected environment.

***CEQA Conclusion*:** Chloride is not a bioaccumulative constituent, thus any increased concentrations under Alternative 5A LLT would not result in adverse chloride bioaccumulation effects on aquatic life or humans. Alternative 5A LLT maintenance would not result in any substantial changes in chloride concentration upstream of the Delta or in the SWP/CVP service area. Relative to existing conditions, the Alternative 5A LLT would result in substantially increased chloride concentrations such that frequency of exceedances of the 250 mg/L Bay-Delta WQCP objective would increase at the San Joaquin River at Antioch (by 6%) and at Mallard Slough (by 2%), and long-term degradation may occur, that may result in adverse effects on the municipal and industrial water supply beneficial use. Relative to the existing conditions, the modeled increased chloride concentrations and degradation in the western Delta could further contribute, at measurable levels (i.e., over a doubling of concentration), to the existing 303(d) listed impairment due to chloride in Suisun Marsh for the protection of fish and wildlife. Based on these findings, this impact is determined to be potentially significant due to increased chloride concentrations and degradation at western and interior Delta locations and its effects on municipal and industrial water supply, aquatic life, and fish and wildlife beneficial uses.

While implementation of Mitigation Measure WQ-7 may reduce this impact, the feasibility and effectiveness of this mitigation measures is uncertain. Therefore, the available mitigation would not necessarily reduce the impact to a level that would be less than significant.

Mitigation Measure WQ-7: Conduct additional evaluation and modeling of increased chloride levels and develop and implement phased actions to reduce levels

Please see Mitigation Measure WQ-7 under Impact WQ-7 in the discussion of Alternative 1A.

Impact WQ-8: Effects on chloride concentrations resulting from implementation of CM2–CM22

Under Alternative 5A LLT, the types and geographic extent of effects on chloride concentrations in the Delta as a result of implementation of the other conservation measures (i.e., CM2-CM22) would be similar to, and undistinguishable from, those effects previously described for Alternative 1A LLT. The conservation measures would present no new direct sources of chloride to the affected environment. Moreover, some habitat restoration conservation measures (CM4-10) would occur on lands within the Delta currently used for irrigated agriculture, thus replacing agricultural land uses with restored tidal wetlands, floodplain, and related channel margin and off-channel habitats. The potential reduction in irrigated lands within the Delta may result in reduced discharges of agricultural field drainage with elevated chloride concentrations, which would be considered an improvement compared to existing conditions.

***CEQA Conclusion*:** Implementation of the CM2-CM22 for Alternative 5A LLT would not present new or substantially changed sources of chloride to the affected environment upstream of the Delta, within Delta, or in the SWP/CVP service area. Replacement of irrigated agricultural land uses in the Delta with habitat restoration conservation measures may result in some reduction in discharge of agricultural field drainage with elevated chloride concentrations, thus resulting in improved water quality conditions. Based on these findings, this impact is considered to be less than significant. No mitigation is required.

Impact WQ-9: Effects on dissolved oxygen resulting from facilities operations and maintenance (CM1)

Effects of CM1 on DO under Alternative 5 are the same as those discussed for Alternative 1A LLT. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-10: Effects on dissolved oxygen resulting from implementation of CM2-CM22

Effects of CM2–23 on DO under Alternative 5 are the same as those discussed for Alternative 1A LLT. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-11: Effects on electrical conductivity concentrations resulting from facilities operations and maintenance (CM1)

Upstream of the Delta

For the same reasons stated for the No Action Alternative LLT, EC levels (highs, lows, typical conditions) in the Sacramento River and its tributaries, the eastside tributaries, their associated reservoirs, and the San Joaquin River upstream of the Delta under Alternative 5 LLT are not expected to be outside the ranges occurring under existing conditions or would occur under the No Action Alternative NT and LLT. Any minor changes in EC levels that could occur under Alternative 5 LLT in water bodies upstream of the Delta would not be of sufficient magnitude, frequency and geographic extent that would cause adverse effects on beneficial uses or substantially degrade water quality with regard to EC.

Delta

Relative to existing conditions, Alternative 5 LLT would result in an increase in the number of days the Bay-Delta WQCP EC objectives would be exceeded in the San Joaquin River at San Andreas Landing and Prisoners Point, and Old River at Tracy Bridge (Appendix H, Table EC-5). The percent of days the San Andreas Landing EC objective would be exceeded for the entire period modeled (1976-1991) would increase from 1% under existing conditions to 4% under Alternative 5 LLT, and the percent of days out of compliance with the EC objective would increase from 1% under existing conditions to 7% under Alternative 5 LLT. The percent of days the Prisoners Point EC objective would be exceeded for the entire period modeled would increase from 6% under existing conditions to 9% under Alternative 5 LLT, and the percent of days out of compliance with the EC objective would increase from 10% under existing conditions to 13% under Alternative 5 LLT. In Old River at Tracy Bridge, the percent of days exceeding the EC objective would increase from 4% under existing conditions to 5% under Alternative 5 LLT; the percent of days out of compliance would increase by <1% and would be 10% under both existing conditions and Alternative 5 LLT. Average EC levels at the western and southern Delta compliance locations would decrease from 2-35% for the entire period modeled and 3-32% during the drought period modeled (1987-1991) (Appendix H, Table EC-16). At the two interior Delta locations, there would be increases in average EC: the S. Fork Mokelumne River at Terminous averageEC would increase 3% for the entire and drought periods modeled; and San Joaquin River at San Andreas Landing average EC would increase 5% for the entire period modeled and 10% during the drought period modeled. On average, EC would increase at San Andreas Landing from January through September. Average EC in the S. Fork Mokelumne River at Terminous would increase from March through December (Appendix H, Table EC-16).

Relative to the No Action Alternative NT, the change in percent compliance with Bay-Delta WQCP EC objectives under Alternative 5 LLT would be similar to that described above relative to existing conditions. The exception is that there would also be a slight increase (1% or less) in the percent of days the EC objective would be exceeded in the San Joaquin River at Vernalis and Brandt Bridge, and Old River near Middle River for the entire period modeled. For the entire period modeled, average EC levels would increase at all Delta compliance locations relative to the No Action Alternative NT, except in Three Mile Slough near the Sacramento River and the San Joaquin River at Jersey Point. The greatest average EC increase would occur in the San Joaquin River at San Andreas Landing (15%); the increase at the other locations would be 3% (Appendix H, Table EC-16). Similarly, during the drought period modeled, average EC would increase at all locations, except Three Mile Slough and San Joaquin River at Jersey Point. The greatest average EC increase during the drought period modeled would occur in the San Joaquin River at San Andreas Landing (18%); the increase at the other locations would be 0-3% (Appendix H, Table EC-16).

Relative to the No Action Alternative LLT, the locations with an increased frequency of exceedance of the Bay-Delta WQCP EC objectives under Alternative 5 LLT would differ from that described relative to the No Action Alternative NT (Appendix H, Table EC-5). The percent of days exceeding EC objectives and percent of days out of compliance would increase at: San Joaquin River at Jersey Point, San Andreas Landing, and Prisoners Point; and Old River near Middle River and at Tracy Bridge. The increase in percent of days exceeding the EC objective would be 8% at Prisoners Point and 5% or less at the remaining locations. The increase in percent of days out of compliance would be 12% at Prisoners Point and 6% or less at the remaining locations. Average EC would increase similar to that described above relative to the No Action Alternative NT.

For Suisun Marsh, October-May is the period when Bay-Delta WQCP EC objectives for protection of fish and wildlife apply. Long-term average EC would increase under Alternative 5 LLT, relative to existing conditions, during the months of March through May by 0.4-0.6 mS/cm in the Sacramento River at Collinsville (Appendix H, Table EC-21). Long-term average EC would decrease relative to existing conditions in Montezuma Slough at National Steel during October-May (Appendix H, Table EC-22). The most substantial increase would occur near Beldon Landing, with long-term average EC levels increasing by 1.6-5.0 mS/cm, depending on the month, at least doubling during some months the long-term average EC relative to existing conditions (Appendix H, Table EC-23). Sunrise Duck Club and Volanti Slough also would have long-term average EC increases during all months of 0.9-2.8 mS/cm (Appendix H, Tables EC-24 and EC-25). The degree to which the long-term average EC increases would cause exceedance of Bay-Delta WQCP objectives is unknown, because objectives are expressed as a monthly average of daily high tide EC, which does not have to be met if it can be demonstrated "equivalent or better protection will be provided at the location" (State Water Resources Control Board 2006:14). The described long-term average EC increase may, or may not, contribute to adverse effects on beneficial uses, depending on how and when wetlands are flooded, soil leaching cycles, and how recirculation of water is managed, and future actions taken with respect to the marsh. However, the EC increases at certain locations would be substantial and it is uncertain the degree to which current management plans for the Suisun Marsh would be able to address these substantially higher EC levels and protect beneficial uses. Thus, these increased EC levels in Suisun Marsh are considered to have a potentially adverse effect on marsh beneficial uses. Long-term average EC increases in Suisun Marsh under Alternative 5 LLT relative to the No Action Alternative NT and LLT would be similar to the increases relative to existing conditions.

Given that the southern Delta is Clean Water Act section 303(d) listed as impaired due to elevated EC, the increase in the incidence of exceedance of EC objectives under Alternative 5 LLT, relative to existing conditions and the No Action Alternative NT and LLT, has the potential to contribute to additional impairment and potentially adversely affect beneficial uses. Suisun Marsh also is section 303(d) listed as impaired due to elevated EC, and the potential increases in long-term average EC concentrations could contribute to additional impairment, because the increases would be double that relative to existing conditions and the No Action Alternative NT and LLT.

SWP/CVP Export Service Area

At the Banks and Jones pumping plants, Alternative 5 LLT would result in no exceedances of the Bay-Delta WQCP's 1,000 µmhos/cm EC objective for the entire period modeled (Appendix H, Table EC-10). Thus, there would be no adverse effect to the beneficial uses in the SWP/CVP Export Service Areas using water pumped at this location under the Alternative 5 LLT.

At the Banks pumping plant, relative to existing conditions, average EC levels under Alternative 5 LLT would decrease 19% for the entire period modeled and 18% during the drought period modeled. Relative to the No Action Alternative NT, average EC levels would decrease by 12% for the entire period modeled and 11% during the drought period modeled. Similar decreases in average EC would occur relative to the No Action Alternative LLT. (Appendix H, Table EC-16)

At the Jones pumping plant, relative to existing conditions, average EC levels under Alternative 5 LLT would decrease 15% for the entire period modeled and 16% during the drought period modeled. Relative to the No Action Alternative NT, average EC levels would decrease by 9% for the entire period modeled and 10% during the drought period modeled. Similar decreases in average EC would occur relative to the No Action Alternative LLT. (Appendix H, Table EC-16)

Based on the decreases in long-term average EC levels that would occur at the Banks and Jones pumping plants, Alternative 5 LLT would not cause degradation of water quality with respect to EC in the SWP/CVP Export Service Areas; rather, Alternative 5 LLT would improve long-term average EC conditions in the SWP/CVP Export Service Areas.

Commensurate with the EC decrease in exported waters, an improvement in lower San Joaquin River average EC levels would be expected since EC in the lower San Joaquin River is, in part, related to irrigation water deliveries from the Delta. While the magnitude of this expected lower San Joaquin River improvement in EC is difficult to predict, the relative decrease in overall loading of EC-elevating constituents to the Export Service Areas would likely alleviate or lessen any expected increase in EC at Vernalis related to decreased annual average San Joaquin River flows (see EC impact discussion under No Action Alternative LLT).

The export area of the Delta is listed on the state's CWA Section 303(d) list as impaired due to elevated EC. Alternative 5 LLT would result in lower average EC levels relative to existing conditions and the No Action Alternative NT and LLT and, thus, would not contribute to additional beneficial use impairment related to elevated EC in the SWP/CVP Export Service Areas waters.

CEQA Conclusion: Relative to existing conditions, Alternative 5 LLT would not result in any substantial increases in long-term average EC levels upstream of the Delta or in the SWP/CVP Export Service Areas. In the Delta region, Alternative 5 LLT would result in an increase in the frequency with which Bay-Delta WQCP EC objectives are exceeded for the entire period modeled (1976-1991): in the San Joaquin River at San Andreas Landing (agricultural objective; 3% increase) and Prisoners Point (fish and wildlife objective; 3% increase), both in the interior Delta; and in Old River at Tracy Bridge (agricultural objective; 1% increase) in the southern Delta. Further, longterm average EC levels would increase in the San Joaquin River at San Andreas Landing by 5% during for the entire period modeled and 10% during the drought period modeled. The increases in long-term and drought period average EC levels and increased frequency of exceedance of EC objectives that would occur in the San Joaquin River at San Andreas Landing would potentially contribute to adverse effects on the agricultural beneficial uses in the interior Delta. Further, the increased frequency of exceedance of the fish and wildlife objective at Prisoners Point could contribute to adverse effects on aquatic life. Because EC is not bioaccumulative, the increases in long-term average EC levels would not directly cause bioaccumulative problems in aquatic life or humans. The southern Delta is Clean Water Act section 303(d) listed for elevated EC and the increased frequency of exceedance of EC objectives that would occur in this portion of the Delta could make beneficial use impairment measurably worse. This impact is considered to be potentially significant.

Further, relative to existing conditions, Alternative 5 LLT would result in substantial increases in long-term average EC during the months of October through May in Suisun Marsh, such that EC levels would be double that relative to existing conditions. The increases in long-term average EC levels that would occur in Suisun Marsh could further degrade existing EC levels and thus contribute additionally to adverse effects on the fish and wildlife beneficial uses. Because EC is not bioaccumulative, the increases in long-term average EC levels would not directly cause bioaccumulative problems in fish and wildlife. Suisun Marsh is Clean Water Act section 303(d) listed for elevated EC and the increases in long-term average EC that would occur in the marsh could make beneficial use impairment measurably worse. This impact is considered to be potentially significant.

While Mitigation Measure WQ-11 may reduce these impacts, the feasibility and effectiveness of this mitigation measures is uncertain. Therefore, the available mitigation would not necessarily reduce the impact to a level that would be less than significant.

Mitigation Measure WQ-11: Reduce, avoid, and compensate for reduced water quality conditions

Please see Mitigation Measure WQ-11 under Impact WQ-11 in the discussion of Alternative 1A.

Impact WQ-12: Effects on electrical conductivity resulting from implementation of CM2-CM22

Effects of CM2-CM22 on EC under Alternative 5 LLT are the same as those discussed for Alternative 1A LLT. There would be no adverse effect. Under CEQA, this impact would be considered less than significant. No mitigation is required.

Impact WQ-13: Effects on mercury concentrations resulting from facilities operations and maintenance (CM1)

[*Note to Lead Agencies: This assessment is in preparation*].

Impact WQ-14: Effects on mercury concentrations resulting from implementation of CM2–23

[*Note to Lead Agencies: This assessment is in preparation*].

Impact WQ-15: Effects on nitrate concentrations resulting from facilities operations and maintenance (CM1)

Upstream of the Delta

For the same reasons stated for the No Action Alternative LLT, Alternative 5 LLT would have negligible, if any, impact on nitrate concentrations in the rivers and reservoirs upstream of the Delta in the Sacramento River watershed relative to existing conditions and the No Action Alternative NT and LLT.

Under Alternative 5 LLT, modeling indicates that long-term annual average flows on the San Joaquin River would decrease by an estimated 6%, relative to existing conditions, 5% relative to No Action NT, and would remain virtually the same relative to No Action LLT (crossreference to Modeling Data Appendix, CALSIM Flow Data for Vernalis). Given these relatively small decreases in flows and the weak correlation between nitrate and flows in the San Joaquin River (see Nitrate Appendix J Figure 2), it is expected that nitrate concentrations in the San Joaquin River will be minimally affected, if at all, by changes in flow rates under Alternative 5 LLT.

Any negligible changes in nitrate-N concentrations that may occur in the water bodies of the affected environment located upstream of the Delta would not be of frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the quality of these water bodies, with regards to nitrate.

Delta

Results of the mixing calculations indicate that under Alternative 5 LLT, relative to existing conditions, No Action NT, and No Action LLT, nitrate concentrations throughout the Delta are anticipated to remain low (<1.4 mg/L-N) relative to adopted objectives (Nitrate Appendix J Table 19 and 20). Although changes at specific Delta locations and for specific months may be substantial on a relative basis, the absolute concentration of nitrate in Delta waters would remain low (<1.4 mg/L-N) in relation to the drinking water MCL of 10 mg/L-N, as well as all other thresholds identified in Table XX. Long-term average nitrate concentrations are anticipated to remain below 1 mg/L-N at all 11 assessment locations except the San Joaquin River at Buckley Cove, where long-term average concentrations would be somewhat above 1 mg/L-N. Nevertheless, at this location, long-term average nitrate concentration would be somewhat reduced under Alternative 5 LLT, relative to existing conditions, similar to the No Action NT, and slightly increased relative to the No Action LLT. No additional exceedances of the MCL are anticipated at any location (Nitrate Appendix J Table 19). On a monthly average basis and on a long term annual average basis, for all modeled years and for the drought period (1987-1991) only, use of assimilative capacity available under existing conditions, No Action NT, and No Action LLT, relative to the drinking water MCL of 10 mg/L-N, was low or negligible (i.e., <5%) for all locations and months, except San Joaquin River at Buckley Cove in August, which showed a 5.6% use of assimilative capacity available under the No Action LLT, for the drought period (1987-1991) (Nitrate Appendix J Table 21).

Nitrate concentrations will likely be higher than the modeling results indicate in certain locations, including: (1) in the Sacramento River between Freeport and Mallard Island and other areas in the Delta downstream of Freeport that are influenced by Sacramento River water, the increase becoming greater with increasing distance downstream, due to conversion of ammonia from the SRWTP discharge at Freeport (under existing conditions and No Action Alternative NT only, since upgrades to SRWTP that substantially reduce ammonia concentrations in the Sacramento River downstream of Freeport are assumed in the LLT; see the Ammonia section of this chapter for further discussion); (2) immediately downstream of wastewater treatment plants that practice nitrification, but not denitrification (e.g., City of Rio Vista Beach WWTF, Town of Discovery Bay WWTF, City of Stockton RWCF).

The effect of (1) (above) is expected to be small, on the order of 1 mg/L nitrate as N or less in the existing conditions and No Action Alternative NT. This is because the existing increase appears to be from approximately 0.1 mg/L-N to approximately 0.4-0.5 mg/L-N over this reach, due to approximately a 1:1 conversion of ammonia-N to nitrate-N (CVWQCB 2010:32). Because this nitrate is assumed not to be generated under Alternative 5 LLT, average concentrations would be expected to decrease under Alternative 5 LLT in this reach of the Sacramento River relative to existing conditions and the No Action Alternative NT. Regarding number (2) (above), for all such facilities in the Delta, the Regional Water Boards have issued NPDES permits that allow discharge of wastewater containing nitrate into the Delta, and under these permits, the State has determined that no beneficial uses are adversely affected by the discharge, and that the discharger's use of available assimilative capacity of the water body is acceptable. When dilution is necessary in order for the discharge to be in compliance with the Basin Plans (which incorporate the 10 mg/L-N MCL by reference), not all of the assimilative capacity of the receiving water is granted to the discharger. Thus, limited decreases in flows are not anticipated to result in systemic exceedances of the MCLs by these POTWs. Furthermore, NPDES permits are renewed on a 5-year basis, and thus, if under changes in flows, dilution was no longer sufficient to maintain nitrate below the MCL in the receiving water, the NPDES permit renewal process would address such cases.

Therefore, any increases in nitrate-N concentrations that may occur at certain locations within the Delta would not be of frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the water quality at these locations, with regards to nitrate.

SWP/CVP Export Service Areas

Assessment of effects of nitrate in the SWP and CVP Export Service Areas is based on effects on nitrate-N at the Banks and Jones pumping plants.

Results of the mixing calculations indicate that under Alternative 5 LLT, relative to existing conditions, No Action NT, and No Action LLT, nitrate concentrations at Banks and Jones pumping plants are anticipated to decrease on a long-term average annual basis (Nitrate Appendix J Table 19 and 20). During the late summer, particularly in the drought period assessed, concentrations are expected to increase substantially on a relative basis (i.e., >50%), but the absolute value of these changes (i.e., in mg/L-N) is small. Additionally, given the many factors that contribute to potential algal blooms in the SWP and CVP canals within the Export Service Area, and the lack of studies that have shown a direct relationship between nutrient concentrations in the canals and reservoirs and problematic algal blooms in these water bodies, there is no basis to conclude that these small (i.e., generally <0.3 mg/L-N), seasonal increases in nitrate concentrations would increase the potential for problem algal blooms in the SWP and CVP Export Service Area. No additional exceedances of the MCL are anticipated (Nitrate Appendix J Table 19). On a monthly average basis and on a long term annual average basis, for all modeled years and for the drought period (1987-1991) only, use of assimilative capacity available under existing conditions and No Action NT, relative to the 10 mg/L-N MCL, was negligible for both Banks and Jones pumping plants (Nitrate Appendix J Table 21).

Any increases in nitrate-N concentrations that may occur in water exported via Banks and Jones pumping plants are not expected to result in an adverse effects to beneficial uses or substantially degrade the quality of exported water, with regards to nitrate.

CEQA Conclusion: There would be no substantial, long-term increase in nitrate-N concentrations in the rivers and reservoirs upstream of the Delta, in the Delta Region, or the waters exported to the CVP and SWP service areas under Alternative 5 LLT relative to existing conditions. As such, this alternative is not expected to cause additional exceedance of applicable water quality objectives/criteria by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. Because nitrate concentrations are not expected to increase substantially, no long-term water quality degradation is expected to occur and, thus, no adverse effects to beneficial uses would occur. Nitrate is not 303(d) listed within the affected environment and thus any increases than may occur in some areas and months would not make any existing nitrate-related impairment measurably worse because no such impairments currently exist. Because nitrate is not bioaccumulative, increases that may occur in some areas and months would not bioaccumulate to greater levels in aquatic organisms that would, in turn, pose substantial health risks to fish, wildlife, or humans. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-16: Effects on nitrate concentrations resulting from implementation of CM2–23

Effects of CM2–23 on nitrate under Alternative 5 LLT are the same as those discussed for Alternative 1A LLT. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-17: Effects on dissolved organic carbon concentrations resulting from facilities operations and maintenance (CM1)

Upstream of the Delta

Under Alternative 5 LLT, there would be no substantial change to the sources of DOC within the watersheds upstream of the Delta. Moreover, long-term average flow and DOC levels in the Sacramento River at Hood and San Joaquin River at Vernalis are poorly correlated. Thus changes in system operations and resulting reservoir storage levels and river flows would not be expected to cause a substantial long-term change in DOC concentrations in the water bodies upstream of the Delta. Any negligible changes in DOC levels in water bodies upstream of the Delta under Alternative 5 LLT, relative to existing conditions and the No Action Alternative NT and LLT, would not be of sufficient frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the quality of these water bodies, with regards to DOC.

Delta

Under Alternative 5 LLT, the geographic extent of effects pertaining to long-term average DOC concentrations in the Delta would be similar to that previously described for Alternative 1A LLT, although the magnitude of predicted long-term change and relative frequency of concentration threshold exceedances would be distributed differently. Modeled effects would be greatest at Franks Tract, Rock Slough, and Contra Costa PP No. 1., where for the 16-year hydrologic period and the modeled drought period, long-term average concentration increases ranging from 0.2-0.3 mg/L would be predicted (≤8% net increase) (Appendix 8K, DOC Table 6). Increases in long-term average concentrations would correspond to more frequent concentration threshold exceedances, with the greatest change occurring at Rock Slough and Contra Costa PP No. 1 locations. For Rock Slough, long-term average DOC concentrations exceeding 3 mg/L would increase from 52% under existing conditions to 64% under the Alternative 5 LLT (an increase from 47% to 62% for the drought period), and concentrations exceeding 4 mg/L would increase from 30% to 32% (32% to 37% for the drought period). For Contra Costa PP No. 1, long-term average DOC concentrations exceeding 3 mg/L would increase from 52% under existing conditions to 70% under Alternative 5 LLT (45% to 75% for the drought period), and concentrations exceeding 4 mg/L would increase from 32% to 35% (35% to 40% for the drought period). Relative change in frequency of threshold exceedance for other assessment locations would be similar or less. While Alternative 5 LLT would generally lead to slightly higher long-term average DOC concentrations (≤0.3 mg/L) at some municipal water intakes and Delta interior locations, the predicted change would not be expected to adversely affect MUN beneficial uses, or any other beneficial use.

In comparison, Alternative 5 LLT relative to the No Action Alternative NT and No Action Alternative LLT would generally result in a similar magnitude of change to that discussed for the comparison to existing conditions. Maximum increases of 0.2- 0.3 mg/L DOC (i.e., ≤8%) would be predicted at Franks Tract, Rock Slough, and Contra Costa PP No. 1 relative to No Action Alternative NT, while maximum increases at these locations would be slightly less (i.e., between 0.1-0.2 mg/L) when compared to No Action Alternative LLT (Appendix 8K, DOC Table 6). Threshold concentration exceedance frequency trends would also be similar to that discussed for the existing condition comparison, with exception to the predicted 4 mg/L exceedance frequency at Buckley Cove. In comparison to the No Action Alternative NT, the frequency which long-term average DOC concentrations exceeded 4 mg/L at Buckley Cove would increase from 23% to 31% (37% to 53% for the modeled drought period), with slightly smaller increases when comparing to No Action Alternative LLT. While the Alternative 5 LLT would generally lead to slightly higher long-term average DOC concentrations at some Delta assessment locations when compared to No Action Alternative NT and No Action Alternative LLT conditions, the predicted change would not be expected to adversely affect MUN beneficial uses, or any other beneficial use, particularly when considering the relatively small change in long-term annual average concentration.

As discussed for Alternative 1A, substantial change in ambient DOC concentrations would need to occur before significant changes in drinking water treatment plant design or operations are triggered. The increases in long-term average DOC concentrations estimated to occur at various Delta locations under Alternative 5 are of sufficiently small magnitude that they will not require existing drinking water treatment plants to substantially upgrade treatment for DOC removal above levels currently employed.

Relative to existing, No Action Alternative NT, and No Action Alternative LLT conditions, Alternative 5 LLT would lead to predicted improvements in long-term average DOC concentrations at Barker Slough, Banks and Jones pumping plants. At these locations, long-term average DOC concentrations would be predicted to decrease by as much as <0.1 - 0.3 mg/L, with exception to Jones. Relatively to existing conditions, long-term average DOC concentrations for the modeled drought period would be expected to increase by 0.1 mg/L at Jones, but remain nearly the same under No Action Alternative NT and No Action Alternative LLT comparisons.

SWP/CVP Export Service Areas

Under Alternative 5 LLT, modeled long-term average DOC concentrations would decrease at Banks and Jones pumping plants for the modeled 16-year hydrologic period, relative to existing conditions, No Action Alternative NT, and No Action Alternative LLT. Relative to existing conditions, long-term average DOC concentrations at Banks would be predicted to decrease by 0.3 mg/L (0.1 mg/L during drought period) (Appendix 8K, DOC Table 6). At Jones, long-term average DOC concentrations would be predicted to decrease by 0.2 mg/L, but be predicted to increase by 0.1 mg/L for the modeled drought period. Such decreases in long-term average DOC, however, would not necessarily translate into lower exceedance frequencies for concentration thresholds. To the contrary, long-term average DOC concentrations at Banks exceeding 3 mg/L would increase from 64% under existing conditions to 69% under Alternative 5 LLT (57% to 83% for the drought period), and at Jones would increase from 71% to 78% (72% to 93% for the drought period). Relative to the 4 mg/L concentration threshold, long-term average DOC concentrations at Banks would decrease from 33% under existing conditions to 27% under Alternative 5 LLT, but would increase slightly from 42% to 44% for the modeled drought period. At Jones, concentrations exceeding 4 mg/L would increase slightly from 26% to 27% (35% to 39% for the drought period). Frequency of exceedance comparisons to No Action Alternative NT and No Action Alternative LLT yield similar trends, but with slightly smaller 16-year hydrologic period and drought period changes. Overall, modeling results for the SWP/CVP Export Service Areas predict a slight long-term improvement in Export Service Areas water quality respective to DOC. This improvement is principally obtained through overall lower long-term average DOC concentrations at Banks and Jones.

Similar to the discussion pertaining to the No Action Alternative LLT, maintenance of SWP and CVP facilities under Alternative 5 LLT would not be expected to create new sources of DOC or contribute towards a substantial change in existing sources of DOC in the affected area. Maintenance activities would not be expected to cause any substantial change in long-term average DOC concentrations such that MUN beneficial uses, or any other beneficial use, would be adversely affected.

***CEQA Conclusion*:** Relative to existing conditions, Alternative 5 LLT operation and maintenance would not result in any substantial change in long-term average DOC concentration upstream of the Delta or result in substantial increase in the frequency with which long-term average DOC concentrations exceeds 2, 3, or 4 mg/L levels at the 11 assessment locations analyzed for the Delta. Modeled long-term average DOC concentrations would increase by no more than 0.3 mg/L at any single Delta assessment location (i.e., ≤8% relative increase), with long-term average concentrations estimated to remain at or below 4.0 mg/L at all Delta locations assessed, with the exception of Buckley Cove on the San Joaquin River during the drought period modeled. Nevertheless, long-term average concentrations at Buckley Cove are expected to decrease slightly during the drought period, relative to existing conditions. The increases in long-term average DOC concentration that could occur within the Delta would not be of sufficient magnitude to adversely affect the MUN beneficial use, or any other beneficial uses, of Delta waters or waters of the SWP/CVP Service Area. Because DOC is not bioaccumulative, the increases in long-term average DOC concentrations would not directly cause bioaccumulative problems in aquatic life or humans. Finally, DOC is not causing beneficial use impairments and thus is not 303(d) listed for any water body within the affected environment. Thus, the increases in long-term average DOC that could occur at various locations would not make any beneficial use impairment measurably worse. Because long-term average DOC concentrations are not expected to increase substantially, no long-term water quality degradation with respect to DOC is expected to occur and, thus, no adverse effects on beneficial uses would occur This impact is considered to be less than significant. No mitigation is required.

Impact WQ-18: Effects on dissolved organic carbon concentrations resulting from implementation of CM2-CM22

Conservation components proposed under Alternative 5 LLT would be the same as those proposed under Alternative 1A, except that 25,000 rather than 65,000 acres of tidal habitat would be restored. Effects on DOC resulting from the implementation of CM2-CM22 would be similar to that previously discussed for Alternative 1A LLT, except that the reduced acreage of proposed tidal habitat would reduce the overall Alternative 5 LLT related DOC loading to the Delta. While this reduced acreage would result in reduced DOC loading relative to other action Alternatives, conservation measures CM4-CM7 and CM10 could still contribute substantial amounts of DOC to raw drinking water supplies, largely depending on final design and operational criteria for the related wetland and riparian habitat restoration activities. Substantially increased long-term average DOC in raw water supplies could lead to a need for treatment plant upgrades in order to appropriately manage DBP formation in treated drinking water. This potential for future DOC increases would lead to substantially greater associated risk of long-term adverse effects on the MUN beneficial use.

***CEQA Conclusion*:** Effects of CM4-CM7 and CM10 on DOC under Alternative 5 LLT would be similar to those discussed for Alternative 1A LLT, although the overall magnitude of effect is expected to be less due to the smaller acreage proposed for tidal habitat restoration. Regardless of the smaller proposed acreage, these restoration activities could present a substantial source of DOC loading to the Delta. Similar to Alternative 1A LLT, this impact is considered to be significant and mitigation is required. It is uncertain whether implementation of Mitigation Measure WQ-18 would reduce identified impacts to a less than significant level. Hence, this impact could remain significant after mitigation.

Mitigation Measure WQ-18: Design wetland and riparian habitat features to minimize effects on municipal intakes

Please see Mitigation Measure WQ-18 under Impact WQ-18 in the discussion of Alternative 1A.

Impact WQ-19: Effects on pathogens resulting from facilities operations and maintenance

Effects of CM1 on pathogens under Alternative 5 are the same as those discussed for Alternative 1A LLT. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-20: Effects on pathogens resulting from implementation of CM2–CM22

Effects of CM2–CM22on pathogens under Alternative 5 are the same as those discussed for Alternative 1A LLT. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-21: Effects on pesticide concentrations resulting from facilities operations and maintenance (CM1)

Upstream of the Delta

For the same reasons stated for the No Action Alternative LLT, under Alternative 5 LLT no specific operations or maintenance activity of the SWP or CVP would substantially drive a change in pesticide use, and thus pesticide sources would remain unaffected upstream of the Delta. Nevertheless, changes in the timing and magnitude of reservoir releases could have an effect on available dilution capacity along river segments such as the Sacramento, Feather, American, and San Joaquin Rivers.

Under Alternative 5 LLT, winter (November –March) and summer (April – October) season average flow rates on the Sacramento River at Freeport, American River at Nimbus, Feather River at Thermalito and the San Joaquin River at Vernalis would change. Relative to existing condition, No Action Alternative NT and No Action Alternative LLT, seasonal average flow rates on the Sacramento would decrease no more than 5% during the summer and 4% during the winter relative to existing conditions (Appendix 8L, Seasonal average flows Tables 1-4). On the Feather River, average flow rates would decrease no more than 4% during the summer, but would increase by as much as 12% in the winter. American River average flow rates would decrease by as much as 15% in the summer and 1% in the winter. Seasonal average flow rates on the San Joaquin River would decrease by as much as 12% in the summer, but increase by as much as 3% in the winter. For the same reasons stated for the No Action Alternative LLT, decreased seasonal average flow of ≤15% is not considered to be of sufficient magnitude to substantially increase pesticide concentrations or alter the long-term risk of pesticide-related toxicity to aquatic life, nor adversely affect other beneficial uses of water bodies upstream of the Delta.

Delta

Sources of diuron, OP and pyrethroid insecticides to the Plan Area include direct input of surface runoff from in-Delta agriculture and Delta urbanized areas as well inputs from rivers upstream of the Delta. Similar to Upstream of the Delta, CVP/SWP operations would not affect these sources.

Under Alternative 5 LLT, the distribution and mixing of Delta source waters would change. Percent change in monthly average source water fraction were evaluated for the modeled 16-year (1976-1991) hydrologic period and a representative drought period (1987-1991), with special attention given to changes in San Joaquin River, Sacramento River and Delta Agriculture sources water fractions. Relative to existing conditions, under Alternative 5 LLT modeled San Joaquin River fractions would increase greater than 10% (excluding Banks and Jones pumping plants) at Rock Slough and Contra Costa PP No. 1 (Appendix 8D, Source Water Fingerprinting). At Rock Slough, modeled San Joaquin River source water fractions would increase 16% during November (13% for the modeled drought period), while at Contra Costa PP No. 1 San Joaquin River source water fractions would increase 15% during November and 12% during March. Corresponding increases for the modeled drought period would not be greater than 8% at Contra Costa PP No. 1. Relative to existing conditions, there would be no modeled increases in Sacramento River fractions greater than 14% (with exception to Banks and Jones which are discussed below) and Delta agricultural fractions greater than 7%. These modeled changes in the source water fractions of Sacramento, San Joaquin and Delta agriculture water are not of sufficient magnitude to substantially alter the long-term risk of pesticide-related toxicity to aquatic life, nor adversely affect other beneficial uses of the Delta.

When compared to No Action Alternative NT and No Action Alternative LLT, changes in source water fractions would be similar in season, geographic extent, and magnitude to those discussed for existing conditions with exception to Buckley Cove. At Buckley Cove, modeled San Joaquin River fractions would increase 12% in July (25% for the modeled drought period) and 22% (43% for the modeled drought period) in August when compared to No Action Alternative LLT (Appendix 8D, Source Water Fingerprinting). These increases would primarily balance through decreases in Sacramento River water and eastsidetributary waters, and as a result the San Joaquin River would account for as much as 72% of the total source water volume at Buckley Cove in July and August (as much as 54% for the modeled drought period). While the source water and potential pesticide related toxicity co-occurrence predictions do not mean adverse effect would occur, such considerable modeled increases in summer source water fraction at Buckley Cove could substantially alter the long-term risk of pesticide-related toxicity to aquatic life, given the apparent greater incidence of pesticides in the San Joaquin River.

These predicted adverse effects on pesticides relative to No Action Alternative LLT fundamentally assume that the present pattern of pesticide incidence in surface water will occur at similar levels into the future. In reality, however, the makeup and character of the pesticide use market in the late long-term (i.e., the year 2060) will not be exactly as it istoday. Current use of chlorpyrifos and diazinon is on the decline with their replacement by pyrethroids on the rise, yet in this assessment it is the apparent greater incidence of diazinon and chlorpyrifos on the San Joaquin River that serves as the basis for concluding that substantially increased San Joaquin River source water fraction would correspond to an increased risk of pesticide-related toxicity to aquatic life. By 2060, however, alternatives pesticides, such as neonicitinoids and biologicals, will likely be a more substantial contributing part of the existing mix of pesticides, and perhaps more prominent. The trend in the development of future-use pesticides is towards reduced risk pesticides, including more biopesticides, with greater targeted specificity, fewer residues, and lower overall non-target toxicity. By 2060 existing chlorpyrifos and diazinon TMDLs for the Sacramento and San Joaquin Rivers will have been in effect for more than 50 years. Moreover, it is reasonable to expect that CWA section 303(d) listings and future additional listings will have developed TMDLs by 2060. To the extent these existing and future TMDL's address current and future-use pesticides, a greater degree of pesticide related source control can be anticipated. Nevertheless, forecasting whether these various efforts will ultimately be successful at resolving current pesticide related impairments requires considerable speculation. While the fundamental assumptions that have guided this assessment of pesticides may be somewhat altered by 2060, these assumptions are informed by actual studies and monitoring data collected from the recent past and, therefore, judging project alternative effects in the future remain most accurate through use of these informed assumptions rather than based on assumptions founded upon future speculative conditions.

SWP/CVP Export Service Areas

Assessment of effects in SWP/CVP Export Service Areas is based on effects seen in the Plan Area at the Banks and Jones pumping plants. Under Alternative 5 LLT, Sacramento River source water fractions would increase substantially at both Banks and Jones pumping plants relative to existing conditions, No Action Alternative NT and No Action Alternative LLT (Appendix 8D, Source Water Fingerprinting). At Banks pumping plant, Sacramento source water fractions would generally increase from 14-28% for March through June (17% for April of the modeled drought period) and at Jones pumping plant Sacramento source water fractions would generally increase from 12-24% for January through June (15-27% for March through May of the modeled drought period). These increases in Sacramento source water fraction would primarily balance through equivalent decreases in San Joaquin River water. Based on the general observation that San Joaquin River, in comparison to the Sacramento River, is a greater contributor of OP insecticides in terms of greater frequency of incidence and presence at concentrations exceeding water quality benchmarks, modeled increases in Sacramento River fraction at Banks and Jones would generally represent an improvement in export water quality respective to pesticides.

***CEQA Conclusion*:** Relative to existing conditions, the Alternative 5 LLT would not result in any substantial change in long-term average pesticide concentration or result in substantial increase in the anticipated frequency with which long-term average pesticide concentrations would exceed aquatic life toxicity thresholds or other beneficial use effect thresholds upstream of the Delta, at the 11 assessment locations analyzed for the Delta, or the SWP/CVP service area. Numerous pesticides are currently used throughout the affected environment, and while some of these pesticides may be bioaccumulative, those present-use pesticides for which there is sufficient evidence for their presence in waters affected by SWP and CVP operations (i.e., diazinon, chlorpyrifos, diuron, and pyrethroids) are not considered bioaccumulative, and thus changes in their concentrations would not directly cause bioaccumulative problems in aquatic life or humans. Furthermore, while there are numerous 303(d) listings throughout the affected environment that name pesticides as the cause for beneficial use impairment, the modeled changes in upstream river flows and Delta source water fractions would not be expected to make any of these beneficial use impairments measurably worse. Because long-term average pesticide concentrations are not expected to increase substantially, no long-term water quality degradation with respect to pesticides is expected to occur and, thus, no adverse effects on beneficial uses would occur. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-22: Effects on pesticide concentrations resulting from implementation of CM2–CM22

Conservation components proposed under Alternative 5 would be the same as those proposed under Alternative 1A, except that 25,000 rather than 65,000 acres of tidal habitat would be restored. As such, effects on pesticides resulting from the implementation of CM2–CM22would be similar to that previously discussed for Alternative 1A LLT, except that the likely overall use of herbicides to control invasive aquatic vegetation would likely be reduced commensurate with the reduction in restored acres of tidal habitat. Nevertheless, herbicides directly applied to water could include adverse effects on non-target aquatic life, such as aquatic invertebrates and beneficial aquatic plants. As such, aquatic life toxicity objectives could be exceeded with sufficient frequency and magnitude such that beneficial uses would be impacted.

***CEQA Conclusion*:** Effects of CM2–CM22 on pesticides under Alternative 5 LLT are the similar as those discussed for Alternative 1A LLT. Potential environmental effects related only to CM13 are considered to be significant. Mitigation is required. While Mitigation Measure WQ-22 is available to partially reduce this impact of pesticides, no feasible mitigation is available that would reduce it to a level that would be less than significant.

Mitigation Measure WQ-22: Implement least toxic integrated pest management strategies

Please see Mitigation Measure WQ-22 under Impact WQ-22 in the discussion of Alternative 1A.

Impact WQ-23: Effects on phosphorus concentrations resulting from facilities operations and maintenance (CM1)

Effects of water facilities and operations (CM1) on phosphorus levels in water bodies of the affected environment under Alternative 3 LLT would be very similar (i.e., nearly the same) as those discussed for Alternative 1A LLT. Consequently, the environmental consequences to phosphorus levels discussed in detail for Alternative 1A LLT also adequately represent the effects under Alternative 3 LLT. Based on this finding, this impact is considered to be less than significant. No mitigation is required.

Impact WQ-24: Effects on phosphorus concentrations resulting from implementation of CM2–CM22

Effects of CM2–23 on phosphorus levels in water bodies of the affected environment under Alternative 5 LLT would be very similar (i.e., nearly the same) as those discussed for Alternative 1A LLT. Consequently, the environmental consequences to phosphorus levels from implementing CM2-CM22 discussed in detail for Alternative 1A LLT also adequately represent the effects of these same actions under Alternative 5 LLT. Based on this finding, this impact is considered to be less than significant. No mitigation is required.

Impact WQ-25: Effects on selenium concentrations resulting from facilities operations and maintenance (CM1)

[*Note to Lead Agencies: This assessment is in preparation*].

Impact WQ-26: Effects on selenium concentrations resulting from implementation of CM2–CM22

[*Note to Lead Agencies: This assessment is in preparation*].

Impact WQ-27: Effects on trace metal concentrations resulting from facilities operations and maintenance (CM1)

Upstream of the Delta

For the same reasons stated for the No Action Alternative LLT, Alternative 5 LLT would result in negligible, and likely immeasurable, increases in trace metal concentrations in the rivers and reservoirs upstream of the Delta, relative to existing conditions, No Action Alternative NT and No Action Alterantive LLT. Effects due to the operation and maintenance of the conveyance facilities are expected to be immeasurable, on an annual and long-term average basis. As such, the Alternative 5 would not be expected to substantially increase the frequency with which applicable Basin Plan objectives or CTR criteria would be exceeded in water bodies of the affected environment located upstream of the Delta or substantially degrade the quality of these water bodies, with regard to trace metals.

Delta

For the same reasons stated for the No Action Alternative LLT, Alternative 5 LLT would not result in substantial increases in trace metal concentrations in the Delta relative to existing conditions, No Action Alternative NT, and No Action Alternative LLT. Effects due to the operation and maintenance of the conveyance facilities are expected to be negligible, on long-term average basis. As such, Alternative 5 would not be expected to substantially increase the frequency with which applicable Basin Plan objectives or CTR criteria would be exceeded in the Delta or substantially degrade the quality of Delta waters, with regard to trace metals.

SWP/CVP Export Service Areas

For the same reasons stated for the No Action Alternative LLT, Alternative 5 LLT would not result in substantial increases in trace metal concentrations in the water exported from the Delta or diverted from the Sacramento River through the proposed conveyance facilities. As such, there is not expected to be substantial changes in trace metal concentrations in the SWP/CVP export service area waters under Alternative 5, relative to existing conditions, No Action Alternative NT, and No Action Alternative LLT. As such, Alternative 5 would not be expected to substantially increase the frequency with which applicable Basin Plan objectives or CTR criteria would be exceeded in the water bodies of the affected environment in the SWP and CVP Service Area or substantially degrade the quality of these water bodies, with regard to trace metals.

CEQA Conclusion: There would be no substantial long-term increase in trace metal concentrations in the rivers and reservoirs upstream of the Delta, in the Delta Region, or the SWP/CVP export service area waters under Alternative 5 relative to existing conditions. As such, this alternative is not expected to cause additional exceedance of applicable water quality objectives by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. Because trace metal concentrations are not expected to increase substantially, no long-term water quality degradation for trace metals is expected to occur and, thus, no adverse effects to beneficial uses would occur. Furthermore, any negligible changes in long-term trace metal concentrations that may occur in water bodies of the affected environment would not be expected to make any existing beneficial use impairments measurably worse. The trace metals discussed in this assessment are not considered bioaccumulative, and thus would not directly cause bioaccumulative problems in aquatic life or humans. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-28: Effects on trace metal concentrations resulting from implementation of CM2–CM22

Conservation components proposed under Alternative 5 would be the same as those proposed under Alternative 1A, except that 25,000 rather than 65,000 acres of tidal habitat would be restored. Effects on trace metals resulting from the implementation of CM2–CM22 would be similar to that previously discussed for Alternative 1A. As they pertain to trace metals, implementation of CM2–CM22 would not be expected to adversely affect beneficial uses of the affected environment or substantially degrade water quality with respect to trace metals.

CEQA Conclusion: Implementation of CM2-CM22 under Alternative 5 would not cause substantial long-term increase in trace metal concentrations in the rivers and reservoirs upstream of the Delta, in the Delta Region, or the SWP/CVP export service area. As such, this alternative is not expected to cause additional exceedance of applicable water quality objectives by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. Because trace metal concentrations are not expected to increase substantially, no long-term water quality degradation for trace metals is expected to occur and, thus, no adverse effects to beneficial uses would occur. Furthermore, any negligible changes in long-term trace metal concentrations that may occur throughout the affected environment would not be expected to make any existing beneficial use impairments measurably worse. The trace metals discussed in this assessment are not considered bioaccumulative, and thus would not directly cause bioaccumulative problems in aquatic life or humans. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-29: Effects on TSS and turbidity resulting from facilities operations and maintenance (CM1)

Effects of CM1 on TSS and turbidity under Alternative 5 are the same as those discussed for Alternative 1A LLT. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-30: Effects on TSS and turbidity resulting from implementation of CM2–CM22

Effects of CM2–CM22 on TSS and turbidity under Alternative 5 are the same as those discussed for Alternative 1A LLT. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-31: Water quality effects resulting from construction-related activities

The conveyance features for CM1 under Alternative 5 would be very similar to those discussed for Alternative 1A. The primary difference between Alternative 5 and Alternative 1A is that under Alternative 5, the fewer number of intakes would result in a reduced level of construction activity.

However, construction techniques and locations of major features of the conveyance system within the Delta would be similar. The remainder of the facilities constructed under Alternative 5, including conservation measures CM2–CM22, would be very similar to, or the same as, those to be constructed for Alternative 1A.

The types of potential construction-related water quality effects associated with implementation of conservation measures CM1–CM22 under Alternative 5 would be very similar to the effects discussed for Alternative 1A LLT, and the effects anticipated with implementation of CM2–CM22 would be essentially identical. However, the contruction of fewer intakes and smaller conveyance features for CM1 under Alternative 5 would be anticipated result in a lower magnitude of construction-related activities. Nevertheless, the construction of CM1 with the environmental commitments and agency permitted construction requirements and BMPs would result in the potential water quality effects being largely avoided and minimized. The specific environmental commitments that would be implemented under Alternative 5 would be similar to those described for Alternative 1A. Consequently, relative to existing conditions, Alternative 5 LLT would not be expected to cause exceedance of applicable water quality objectives/criteria or substantial water quality degradation with respect to constituents of concern, and thus would not adversely affect any beneficial uses upstream of the Delta, in the Delta, or in the SWP and CVP service area.

CEQA Conclusion: Construction-related contaminant discharges would be temporary and intermittent in nature and would involve negligible, if any, discharges of bioaccumulative or 303(d) listed constituents to water bodies of the affected environment. As such, construction activities would not contribute measurably to bioaccumulation of contaminants in organisms or humans or cause 303(d) impairments to be discernibly worse. Because environmental commitments would be implemented under Alternative 5 LLT for construction-related activities along with agency-issues permits that also contain construction requirements to protect water quality, the construction-related effects would not be expected to cause or contribute to a substantial increased frequency of exceedances of water quality objectives/criteria relative to existing conditions, or substantially degrade water quality with respect to the constituents of concern on a long-term average basis, and thus would not adversely affect any beneficial uses in water bodies upstream of the Delta, within the Delta, or in the SWP and CVP service area. Based on these findings, this impact is determined to be less than significant. No mitigation is required.

8.3.4.9 Alternative 6A—Isolated Conveyance with Tunnel and Intakes 1–5 (15,000 cfs; Operational Scenario D)

Alternative 6 would convey up to 15,000 cfs of water from the north Delta to the south Delta through pipelines/tunnels from five screened intakes on the east bank of the Sacramento River between Clarksburg and Walnut Grove. A new Byron Tract Forebay, adjacent to and south of Clifton Court Forebay, would be constructed which would provide water to the south Delta pumping plants. However, this would be an "isolated" conveyance, no longer involving operation of the existing SWP and CVP south Delta export facilities for Clifton Court Forebay and Jones Pumping Plant. Water supply and conveyance operations would follow the guidelines described as Scenario D, which includes fall X2. CM2–CM22 would be implemented under this alternative, and would be the same as those under Alternative 1A. See Chapter 3, *Description of Alternatives*, for additional details on Alternative 6A.

Impact WQ-1: Effects on ammonia concentrations resulting from facilities operations and maintenance (CM1)

Upstream of the Delta

For the same reasons stated for the No Action Alternative LLT, Alternative 6A LLT would have negligible, if any, effect on ammonia concentrations in the rivers and reservoirs upstream of the Delta relative to existing conditions and the No Action Alternative NT and LLT. Any negligible increases in ammonia-N concentrations that could occur in the water bodies of the affected environment located upstream of the Delta would not be of frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the quality of these water bodies, with regard to ammonia.

Delta

Assessment of effects of ammonia under Alternative 6A LLT is the same as discussed under Alternative 1A, except that because flows in the Sacramento River at Freeport are different between the two alternatives, estimated monthly average and long term annual average predicted ammonia-N concentrations in the Sacramento River downstream of Freeport are different.

As Table 8-59 shows, estimated ammonia-N concentrations in the Sacramento River downstream of Freeport (upon full mixing of the SRWTP discharge with river water) under Alternative 6A LLT and the No Action Alternative LLT are expected to be similar. Minor increases in ammonia-N concentrations would occur during July through January and in April, and remaining months would be unchanged or have a minor decrease. Annual average concentrations would be the same under both Alternative 6A LLT and the No Action Alternative LLT. Moreover, the estimated concentrations downstream of Freeport under Alternative 6A LLT would be similar to existing source water concentrations for the San Francisco Bay and San Joaquin River. Consequently, changes in source water fraction anticipated under Alternative 6A LLT, relative to the No Action Alternative LLT, are not expected to substantially increase ammonia concentrations at any Delta locations.

Table 8-59. Estimated Ammonia-N (mg-L as N) Concentrations in the Sacramento River Downstream of the Sacramento Regional Wastewaster Treatment Plant for the No Action Alternative LLT and Alternative 6A LLT

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual Average
No Action Alternative LLT	0.081	0.073	0.061	0.055	0.053	0.055	0.061	0.070	0.072	0.064	0.072	0.069	0.063
Alternative 6A LLT	0.082	0.075	0.062	0.056	0.053	0.055	0.062	0.069	0.072	0.067	0.074	0.071	0.063

Any negligible increases in ammonia-N concentrations that could occur at certain locations in the Delta would not be of frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the water quality at these locations, with regards to ammonia.

SWP/CVP Export Service Areas

The assessment of effects on ammonia in the SWP/CVP Export Service Area is based on assessment of ammonia-N concentrations at Banks and Jones pumping plants. Similar to the discussion for Alternative 1A, under Alternative 6A for areas of the Delta that are influenced by Sacramento River water, including Banks and Jones pumping plants, ammonia-N concentrations are expected to decrease, relative to existing conditions and No Action Alternative NT. This decrease in ammonia-N concentrations for water exported via the south Delta pumps is not expected to result in an adverse effects on beneficial uses or substantially degrade water quality of exported water, with regards to ammonia.

Furthermore, as discussed above for the PlanArea, for all areas of the Delta, including Banks and Jones pumping plants, ammonia-N concentrations are not expected to be substantially different under Alternative 6A LLT, relative to No Action Alternative LLT. Any negligible increases in ammonia-N concentrations that could occur at Banks and Jones pumping plants would not be of frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the water quality at these locations, with regards to ammonia.

***CEQA Conclusion*:** There would be no substantial, long-term increase in ammonia-N concentrations in the rivers and reservoirs upstream of the Delta, in the PlanArea, or the waters exported to the CVP and SWP service areas under Alternative 6A LLT relative to existing conditions. As such, this alternative is not expected to cause additional exceedance of applicable water quality objectives/criteria by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. Because ammonia concentrations are not expected to increase substantially, no long-term water quality degradation is expected to occur and, thus, no adverse effects on beneficial uses would occur. Ammonia is not 303(d) listed within the affected environment and thus any minor increases than could occur in some areas would not make any existing ammonia-related impairment measurably worse because no such impairments currently exist. Because ammonia-N is not bioaccumulative, minor increases that could occur in some areas would not bioaccumulate to greater levels in aquatic organisms that would, in turn, pose substantial health risks to fish, wildlife, or humans. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-2: Effects on ammonia concentrations resulting from implementation of CM2–CM22

Effects of CM2–CM22on ammonia under Alternative 6A LLT are the same as those discussed for Alternative 1A LLT. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-3: Effects on boron concentrations resulting from facilities operations and maintenance (CM1)

Upstream of the Delta

Effects of CM1 on boron under Alternative 6A LLT in areas upstream of the Delta would be very similar to the effects discussed for Alternative 1A LLT. There would be no expected change to the sources of boron in the Sacramento and east-side tributary watersheds, and resultant changes in flows from altered system-wide operations would have negligible, if any, effects on the concentration of boron in the rivers and reservoirs of these watersheds. The modeled long-term annual average lower San Joaquin River flow at Vernalis would decrease slightly compared to existing conditions and the No Action Alternative NT, and would be similar compared to the No Action Alternative LLT. The reduced flow would result in possible increases in long-term average boron concentrations of up to about 3% relative to the existing conditions and No Action Alternative NT conditions. The increased boron concentrations would not increase the frequency of exceedances of any applicable objectives or criteria and would not be expected to cause further degradation at measurable levels in the lower San Joaquin River, and thus would not cause the existing impairment there to be discernibly worse. Consequently, Alternative 6A LLT would not be expected to cause exceedance of boron objectives/criteria or substantially degrade water quality with respect to boron, and thus would not adversely affect any beneficial uses of the Sacramento River, the east-side tributaries, associated reservoirs upstream of the Delta, or the San Joaquin River.

Delta

Relative to the existing conditions, No Action Alternative NT, and No Action Alternative LLT, Alternative 6A LLT would result in generally widespread increased long-term average boron concentrations for the 16-year period modeled at the interior and western Delta locations (by as much as 14% at the SF Mokelumne River at Staten Island, 4% at the San Joaquin River at Buckley Cove, 43% at Franks Tract, 75% at Old River at Rock Slough, and 5% at the Sacramento River at Emmaton) (Appendix 8F, Table Bo-16). Implementation of tidal habitat restoration under conservation measure CM4 also may contribute to increased boron concentrations at western Delta assessment locations, and thus would not be anticipated to substantially affect agricultural diversions which occur primarily at interior Delta locations. The long-term annual average and monthly average boron concentrations, for either the 16-year period or drought period modeled, would never exceed the 2,000 μg/L human health advisory objective (i.e., for children) or 500 μg/L agricultural objective at any of the eleven Delta assessment locations, which represents no change from the existing conditions and No Action Alternative NT and LLT conditions (Appendix 8F, Table Bo-3). The increased concentrations at interior Delta locations would result in moderate reductions in the long-term average assimilative capacity of up to 21% at Franks Tract and up to 43% at Old River at Rock Slough locations (Appendix 8F, Table Bo-17). However, because the absolute boron concentrations would still be well below the lowest 500 μg/L objective for the protection of the agricultural beneficial use under Alternative 6A LLT, the levels of boron degradation would not be of sufficient magnitude to substantially increase the risk of exceeding objectives or cause adverse effects to municipal and agricultural water supply beneficial uses, or any other beneficial uses, in the Delta (Appendix 8F, Figure Bo-3).

SWP/CVP Export Service Areas

Effects of CM1 on boron under Alternative 6A LLT in the Delta would be very similar to the effects discussed for Alternative 1A LLT. Under Alternative 6A LLT, long-term average boron concentrations would decrease by as much as 56% at the Banks Pumping Plant and by as much 63% at Jones Pumping Plant relative to existing conditions, No Action Alternative NT, and No Action Alternative LLT (Appendix 8F, Table Bo-16). Commensurate with the decrease in exported boron concentrations, boron concentrations in the lower San Joaquin River may be reduced and would likely alleviate or lessen any expected increase in boron concentrations at Vernalis associated with flow reductions (see discussion of Upstream of the Delta), as well locations in the Delta receiving a large fraction of San Joaquin River water. Reduced export boron concentrations also may contribute to reducing the existing 303(d) impairment in the lower San Joaquin River and associated TMDL actions for reducing boron loading.

Maintenance of SWP and CVP facilities under Alternative 6A LLT would not be expected to create new sources of boron or contribute towards a substantial change in existing sources of boron in the affected environment. Maintenance activities would not be expected to cause any substantial increases in boron concentrations or degradation with respect to boron such that objectives would be exceeded more frequently, or any beneficial uses would be adversely affected anywhere in the affected environment.

CEQA Conclusion: Boron is not a bioaccumulative constituent, thus any increased concentrations under Alternative 6A LLT would not result in adverse boron bioaccumulation effects to aquatic life or humans. Relative to existing conditions, Alternative 6A LLT would not result in any substantial increases in boron concentration upstream of the Delta. Alternative 6A LLT maintenance also would not result in any substantial increases in boron concentrations in the affected environment. Relative to existing conditions, Alternative 6A LLT would not result in substantially increased boron concentrations such that frequency of exceedances of municipal and agricultural water supply objectives would increase. The levels of boron degradation that may occur under Alternative 6A LLT, while widespread in particular at interior Delta locations, would not be of sufficient magnitude to cause substantially increased risk for adverse effects to municipal or agricultural beneficial uses within the affected environment. Long-term average boron concentrations would decrease in Delta water exports to the SWP and CVP service area, which may contribute to reducing the existing 303(d) impairment of agricultural beneficial uses in the lower San Joaquin River. Consequently, Alternative 6A LLT would not be expected to cause any substantial increases in boron concentrations or degradation with respect to boron such that objectives would be exceeded more frequently, or any beneficial uses would be adversely affected anywhere in the affected environment. Based on these findings, this impact is determined to be less than significant. No mitigation is required.

Impact WQ-4: Effects on boron concentrations resulting from implementation of CM2–CM22

Effects of CM2-CM22 on boron under Alternative 6A LLT are the same as those discussed for Alternative 1A LLT. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-5: Effects on bromide concentrations resulting from facilities operations and maintenance (CM1)

Upstream of the Delta

Under Alternative 6A LLT there would be no expected change to the sources of bromide in the Sacramento and eastside tributary watersheds. Bromide loading in these watersheds would remain unchanged and resultant changes in flows form altered system-wide operations under Alternative 6A LLT would have negligible, if any, effects on the concentration of bromide in the rivers and reservoirs of these watersheds. Consequently, Alternative 6A LLT would not be expected to adversely affect the MUN beneficial use, or any other beneficial uses, of the Sacramento River, the eastside tributaries, or their associated reservoirs upstream of the Delta.

Under Alternative 6A LLT, modeling indicates that long-term annual average flows on the San Joaquin River would decrease by 6%, relative to existing conditions, 5% relative to No Action Alternative NT, and would remain virtually the same relative to No Action Alternative LLT. Similar to the No Action Alternative LLT, these decreases in flow would result in possible increase in long-term average bromide concentrations of about 3%, relative to existing conditions, 2% relative to No Action Alternative NT, and less than <1% relative to No Action Alternative LLT. The small increases in lower San Joaquin River bromide levels that could occur under Alternative 6A LLT, relative to existing, No Action Alternative NT, and No Action Alternative LLT conditions would not be expected to adversely affect the MUN beneficial use, or any other beneficial uses, of the lower San Joaquin River.

Delta

Relative to existing conditions, Alternative 6A LLT would result in increases in long-term average bromide concentrations at Staten Island and Barker Slough, while long-term average concentrations would decrease at the other assessment locations (Appendix 8E, Bromide Table 14-15). At Barker Slough, predicted long-term average bromide concentrations would increase from 51 µg/L to 61 µg/L (19% relative increase) for the modeled 16-year hydrologic period and would increase from 54 µg/L to 92 µg/L (73% relative increase) for the modeled drought period. At Barker Slough, the predicted 50 µg/L exceedance frequency would decrease from 49% under existing conditions to 38% under Alternative 6A LLT, but would increase from 55% to 63% during the drought period. At Barker Slough, the predicted 100 µg/L exceedance frequency would increase from 0% under existing conditions to 17% under Alternative 6A LLT, and would increase from 0% to 37% during the drought period. At Staten Island, predicted long-term average bromide concentrations would increase from 50 µg/L to 70 µg/L (41% relative increase) for the modeled 16-year hydrologic period and would increase from 51 µg/L to 70 µg/L (37% relative increase) for the modeled drought period. At Staten Island, increases in average bromide concentrations would correspond to an increased frequency of 50 µg/l threshold exceedance, from 47% under existing conditions to 85% under Alternative 6A LLT (52% to 88% for the modeled drought period), and an increase from 1% to 10% (0% to 5% for the modeled drought period) for the 100 µg/L threshold.Changes in exceedance frequency of the 50 µg/L and 100 µg/L concentration thresholds at other assessment locations would be less considerable.

Due to the relatively small differences between modeled existing conditions and No Action baselines, changes in long-term average bromide concentrations and changes in exceedance frequencies relative to No Action Alternative NT and No Action Alternative LLT are generally of similar magnitude to those previously described for the existing condition comparison (Appendix 8E, Bromide Table 14-15). Modeled long-term average bromide concentration increases at Barker Slough are predicted to increase by 24% (76% for the modeled drought period) relative to No Action Alternative NT, and would increase by 22% (72% for the modeled drought period) relative to No Action Alternative LLT. Modeled long-term average bromide concentration increases at Staten Island are predicted to increase by 40% (36% for the modeled drought period) relative to No Action Alternative NT, and would increase by 45% (41% for the modeled drought period) relative to No Action Alternative LLT. However, unlike the existing conditions comparison, long-term average bromide concentrations at Buckley Cove would increase relative to No Action Alternative NT and No Action Alternative LLT, although the increases would be relatively small (≤4%).

The increase in long-term average bromide concentrations predicted at Barker Slough, principally the relative increase in 100 µg/L exceedance frequency, would result in a substantial change in source water quality for existing drinking water treatment plants drawing water from the North Bay Aqueduct. As discussed for Alternative 1A, drinking water treatment plants obtaining water via the North Bay Aqueduct utilize a variety of conventional and enhanced treatment technologies in order to achieve DBP drinking water criteria. While the implications of such a modeled change in bromide at Barker Slough are difficult to predict, the substantial modeled increases could lead to adverse changes in the formation of disinfection byproducts such that considerable treatment plant upgrades may be necessary in order to achieve equivalent levels of health protection. Increases at Staten Island are also considerable, although there are no existing or foreseeable municipal intakes in the immediate vicinity.

The seasonal intakes at Mallard Slough and City of Antioch are infrequently used due to water quality constraints related to sea water intrusion. On a long-term average basis, bromide at these locations is in excess of 3,000 µg/L, but during seasonal periods of high Delta outflow can be <300 µg/L. Use of the seasonal intakes at Mallard Slough and City of Antioch under Alternative 6A LLT would experience a period average increase in bromide during the months when these intakes would most likely be utilized. For those wet and above normal water year types where mass balance modeling would predict water quality typically suitable for diversion, predicted long-term average bromide would increase from 103 µg/L to 162 µg/L (58% increase) at City of Antioch and would increase from 150 µg/L to 199 µg/L (33% increase) at Mallard Slough relative to existing conditions (Appendix 8E, Bromide Figure 4-5). Increases would be similar for No Action Alternative NT and No Action Alternative LLT comparison. The decisions surrounding the use of these seasonal intakes is largely driven by acceptable water quality, and thus have historically been opportunistic. Opportunity to use these intakes would remain, and the predicted increases in bromide concentrations at the City of Antioch and Mallard Slough intake would not be expected to adversely affect MUN beneficial uses, or any other beneficial use, at these locations.

Relative to existing, No Action Alternative NT, and No Action Alternative LLT conditions, Alternative 6A LLT would lead to predicted improvements in long-term average bromide concentrations at Franks Tract, Rock Slough, and Contra Costa PP No. 1, in addition to Banks and Jones (discussed below). At these locations, long-term average bromide concentrations would be predicted to decrease by as much as 41-61%, depending on baseline comparison.

SWP/CVP Export Service Areas

Under Alternative 6A LLT, improvement in long-term average bromide concentrations would occur at the Banks and Jones pumping plants. Long-term average bromide concentrations for the modeled 16-year hydrologic period at these locations would decrease by as much as 96% relative to existing conditions, No Action Alternative NT, and No Action Alternative LLT (Appendix 8E, Bromide Tables 14-15). As a result, exceedances of the 50 µg/L and 100 µg/L assessment thresholds would be completely eliminated, resulting in considerable overall improvement in Export Service Areas water quality respective to bromide. Commensurate with the decrease in exported bromide, an improvement in lower San Joaquin River bromide would also be observed since bromide in the lower San Joaquin River is principally related to irrigation water deliveries from the Delta. While the magnitude of this expected lower San Joaquin River improvement in bromide is difficult to predict, the relative decrease in overall loading of bromide to the Export Service Areas would likely alleviate or lessen any expected increase in bromide concentrations at Vernalis (see discussion of Upstream of the Delta) as well locations in the Delta receiving a large fraction of San Joaquin River water, such as much of the south Delta.

Similar to the discussion pertaining to the No Action Alternative LLT, maintenance of SWP and CVP facilities under Alternative 6A LLT would not be expected to create new sources of bromide or contribute towards a substantial change in existing sources of bromide in the affected environment. Maintenance activities would not be expected to cause any substantial change in bromide such that MUN beneficial uses, or any other beneficial use, would be adversely affected anywhere in the affected environment.

***CEQA Conclusion*:** Relative to existing conditions, Alternative 6A LLT operation and maintenance would not result in any substantial change in long-term average bromide concentration upstream of the Delta. Furthermore, under Alternative 6A LLT, water exported from the Delta to the SWP/CVP service area would be substantially improved relative to bromide. Bromide is not bioaccumulative, therefore change in long-term average bromide concentrations would not directly cause bioaccumulative problems in aquatic life or humans. Additionally, bromide is not a constituent related to any 303(d) listings. Alternative 6A LLT operation and maintenance activities would not cause substantial long-term degradation to water quality respective to bromide with the exception of water quality at Barker Slough and at Staten Island in the eastern Delta. There are no existing or foreseeable municipal intakes in the vicinity of Staten Island, but Barker Slough is the source of the North Bay Aqueduct. At Barker Slough, modeled long-term annual average concentrations of bromide would increase by 19%, and 73% during the modeled drought period. For the modeled 16-year hydrologic period the frequency of predicted bromide concentrations exceeding 100 μg/L would increase from 0% under existing conditions to 17% under Alternative 6A LLT, while for the modeled drought period, the frequency would increase from 0% to 37%. Substantial changes in long-term average bromide could necessitate changes in treatment plant operation or require treatment plant upgrades in order to maintain DBP compliance. The model predicted change at Barker Slough is substantial and, therefore, would represent a substantially increased risk for adverse effects on existing MUN beneficial uses should treatment upgrades not be undertaken. The impact is considered significant and mitigation is required. Implementation of Mitigation Measure WQ-5 would reduce identified impacts to a less than significant level by relocating the North Bay Aqueduct outside the influence of sea water intrusion.

Mitigation Measure WQ-5: Move the North Bay Aqueduct intake from Barker Slough to the Sacramento River

Please see Mitigation Measure WQ-5 under Impact WQ-5 in the discussion of Alternative 1A.

Impact WQ-6: Effects on bromide concentrations resulting from implementation of CM2–CM22

Conservation components proposed under Alternative 6A LLT would be the same as those proposed under Alternative 1A LLT. As discussed for Alternative 1A LLT, implementation of the CM2-CM22 would not present new or substantially changed sources of bromide to the project area. Some conservation measures may replace or substitute for existing irrigated agriculture in the Delta. This replacement or substitution is not expected to substantially increase or present new sources of bromide. CM2-CM22 would not be expected to cause any substantial change in bromide such that MUN beneficial uses, or any other beneficial use, would be adversely affected anywhere in the affected environment.

***CEQA Conclusion*:** Conservation components proposed under Alternative 6A LLT would be similar to those proposed under Alternative 1A LLT. As such, effects on bromide resulting from the implementation of CM2–CM22 would be similar to that previously discussed for Alternative 1A LLT. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-7: Effects on chloride concentrations resulting from facilities operations and maintenance (CM1)

Upstream of the Delta

Under Alternative 6A LLT there would be no expected change to the sources of chloride in the Sacramento and eastside tributary watersheds. Chloride loading in these watersheds would remain unchanged and resultant changes in flows from altered system-wide operations would have negligible, if any, effects on the concentration of chloride in the rivers and reservoirs of these watersheds. The modeled long-term annual average flows on the lower San Joaquin River at Vernalis would decrease slightly compared to existing conditions and the No Action Alternative NT, and be similar compared to the No Action Alternative LLT. The reduced flow would result in possible increases in long-term average chloride concentrations of about 2%, relative to the existing conditions and No Action Alternative NT conditions, and no change relative to No Action Alternative LLT. Consequently, Alternative 6A LLT would not be expected to cause exceedance of chloride objectives/criteria or substantially degrade water quality with respect to chloride, and thus would not adversely affect any beneficial uses of the Sacramento River, the eastside tributaries, associated reservoirs upstream of the Delta, or the San Joaquin River.

Delta

Relative to the existing conditions, No Action Alternative NT, and No Action Alternative LLT, the long-term average chloride concentrations under Alternative 6A LLT for the 16-year period modeled would be substantially reduced at nine of the assessment locations (Appendix 8G, Chloride Table Cl-25). Moreover, the direction and magnitude of predicted changes for Alternative 6A LLT are similar between the alternatives, thus, the effects relative to existing conditions and the No Action Alternative scenarios are discussed together. The average chloride concentrations would be increased at the North Bay Aqueduct at Barker Slough (up 15%) and San Joaquin River at Staten Island (up 37%) (Appendix 8G, Chloride Table Cl-25). Additionally, implementation of tidal habitat restoration under conservation measure CM4 would increase the tidal exchange volume in the Delta, and thus may contribute to increased chloride concentrations in the Bay source water as a result of increased salinity intrusion. Consequently, while uncertain, the magnitude of chloride increases may be greater than indicated herein and would affect the western Delta assessment locations the most which are influenced to the greatest extent by the Bay source water. The following outlines the modeled chloride changes relative to the applicable objectives and beneficial uses of Delta waters.

Municipal Beneficial Uses

Relative to the 150 mg/L Bay-Delta WQCP objective for municipal and industrial beneficial uses, the plots of monthly average chloride concentrations at the Contra Costa Canal at Pumping Plant #1 for the separate water year types indicates that the number of months above the objective would decrease substantially compared to the existing conditions, No Action Alternative NT, and No Action Alternative LLT, thus indicating complete compliance with this objective would be achieved (Appendix 8G, Figure Cl-6). The modeled chloride concentrations at the San Joaquin River at Antioch location would never meet this objective; however, this represents no change from the existing conditions, No Action Alternative NT, and No Action Alternative LLT.

With respect to the 250 mg/L Bay-Delta WQCP objective, the modeled frequency of exceedances based on monthly average chloride concentrations for the 16-year period modeled would be eliminated at the Contra Costa Canal at Pumping Plant #1 (24% for existing conditions to 0% for

Alternative 6A LLT), thus indicating complete compliance with this objective would be achieved (Appendix 8G, Table Cl-26 and Figure Cl-7). The frequency of exceedances at the San Joaquin River at Antioch also would decrease compared to all of the alternative scenarios (i.e., 9% from 66% for existing conditions to 57%) with no substantial change predicted for Mallard Island (i.e., maximum increase of 1%) (Appendix 8G, Table Cl-27), and no substantial long-term degradation (Appendix 8G, Table Cl-27). Consequently, Alternative 6A LLT would result in improved chloride conditions with respect to municipal and industrial beneficial uses.

Aquatic Life Beneficial Uses

Relative to the 230 mg/L chronic EPA aquatic life criterion, monthly average chloride concentrations would not exceed the criterion at northern and eastern Delta locations, and the frequency of exceedances would decrease at the interior and southern Delta locations compared to the existing conditions, No Action Alternative NT, and No Action Alternative LLT (Appendix 8G, Table Cl-26 and Figure Cl-8) and no substantial long-term degradation (Appendix 8G, Table Cl-28). Consequently, Alternative 6A LLT would result in improved chloride conditions with respect to aquatic life beneficial uses.

303(d) Listed Water Bodies

With respect to the 303(d) listing for chloride in Tom Paine Slough, the monthly average chloride concentrations for the 16-year period modeled at Old River at Tracy Road would generally be similar compared to existing conditions, and thus, would not be further degraded on a long-term basis (Appendix 8G, Figure Cl-8). With respect to Suisun Marsh, the monthly average chloride concentrations for the 16-year period modeled would generally increase compared to existing conditions No Action Alternative NT, and No Action Alternative LLT in some months during October through May at the Sacramento River at Collinsville (Appendix 8G, Figure Cl-9), Mallard Island (Appendix 8G, Figure Cl-7), and increase substantially at Montezuma Slough at Beldon's Landing (i.e., over a doubling of concentration in December through February) (Appendix 8G, Figure Cl-10), thereby contributing to additional, measureable long-term degradation that potentially would adversely affect the necessary actions to reduce chloride loading for any TMDL that is developed.

SWP/CVP Export Service Areas

Under Alternative 6A LLT, long-term average chloride concentrations for the 16-year period modeled at the Banks and Jones pumping plants would decrease by approximately 95% relative to existing conditions, No Action Alternative NT, and No Action Alternative LLT (Appendix 8G, Chloride Table Cl-25). The modeled low-frequency exceedances of objectives present under the existing conditions, No Action Alternative NT, and No Action Alternative LLT would be eliminated under Alternative 6A (Appendix 8G, Chloride Table Cl-26). Consequently, water exported into the SWP/CVP service area would generally be improved with regards to chloride relative to existing conditions, No Action Alternative NT, and No Action Alternative LLT conditions.

Commensurate with the reduced chloride concentrations in water exported to the service area, reduced chloride loading in the lower San Joaquin River would be anticipated which would likely alleviate or lessen any expected increase in chloride at Vernalis related to decreased annual average San Joaquin River flows (see discussion of Upstream of the Delta).

Maintenance of SWP and CVP facilities would not be expected to create new sources of chloride or contribute towards a substantial change in existing sources of chloride in the affected environment.

Maintenance activities would not be expected to cause any substantial change in chloride such that any long-term water quality degradation would occur, thus, beneficial uses would not be adversely affected anywhere in the affected environment.

CEQA Conclusion: Chloride is not a bioaccumulative constituent, thus any increased concentrations under Alternative 6A LLT would not result in adverse chloride bioaccumulation effects on aquatic life or humans. Alternative 6A LLT maintenance would not result in any substantial changes in chloride concentration upstream of the Delta or in the SWP/CVP service area. Relative to existing conditions, Alternative 6A LLT operations would result in substantially reduced chloride concentrations such that exceedances of the 250 mg/L Bay-Delta WQCP objective at the San Joaquin River at Antioch and Mallard Slough would be reduced. However, relative to the existing conditions, the modeled increased chloride concentrations and degradation in the western Delta could still occur and further contribute, at measurable levels (i.e., over a doubling of concentration), to the existing 303(d) listed impairment due to chloride in Suisun Marsh for the protection of fish and wildlife. Based on these findings, this impact is determined to be potentially significant due to increased chloride concentrations and potential adverse effects on fish and wildlife beneficial uses in Suisun Marsh. Based on these findings, this impact is determined to be potentially significant due to increased chloride concentrations and degradation in Suisun Marsh and its effects on fish and wildlife beneficial uses.

While implementation of Mitigation Measure WQ-7 may reduce this impact, the feasibility and effectiveness of this mitigation measures is uncertain. Therefore, the available mitigation would not necessarily reduce the impact to a level that would be less than significant.

Mitigation Measure WQ-7: Conduct additional evaluation and modeling of increased chloride levels and develop and implement phased actions to reduce levels

Please see Mitigation Measure WQ-7 under Impact WQ-7 in the discussion of Alternative 1A.

Because Alternative 6A would not result in adverse effects on municipal and industrial water supply beneficial uses in the western Delta, the emphasis and mitigation actions would be limited to those necessary to reduce or avoid adverse effects on Suisun Marsh.

Impact WQ-8: Effects on chloride concentrations resulting from implementation of CM2–CM22

Under Alternative 6A LLT, the types and geographic extent of effects on chloride concentrations in the Delta as a result of implementation of the other conservation measures (i.e., CM2-CM22) would be similar to, and undistinguishable from, those effects previously described for Alternative 1A LLT. The conservation measures would present no new direct sources of chloride to the affected environment. Moreover, some habitat restoration conservation measures (CM4-10) would occur on lands within the Delta currently used for irrigated agriculture, thus replacing agricultural land uses with restored tidal wetlands, floodplain, and related channel margin and off-channel habitats. The potential reduction in irrigated lands within the Delta may result in reduced discharges of agricultural field drainage with elevated chloride concentrations, which would be considered an improvement compared to existing conditions.

CEQA Conclusion: Implementation of the CM2-CM22 for Alternative 6A LLT would not present new or substantially changed sources of chloride to the affected environment upstream of the Delta, within Delta, or in the SWP/CVP service area. Replacement of irrigated agricultural land uses in the

Delta with habitat restoration conservation measures may result in some reduction in discharge of agricultural field drainage with elevated chloride concentrations, thus resulting in improved water quality conditions. Based on these findings, this impact is considered to be less than significant. No mitigation is required.

Impact WQ-9: Effects on dissolved oxygen resulting from facilities operations and maintenance (CM1)

Effects of CM1 on dissolved oxygen under Alternative 6A are the same as those discussed for Alternative 1A LLT. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-10: Effects on dissolved oxygen resulting from implementation of CM2-CM22

Effects of CM2–23 on dissolved oxygen under Alternative 6A are the same as those discussed for Alternative 1A LLT. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-11: Effects on electrical conductivity concentrations resulting from facilities operations and maintenance (CM1)

Upstream of the Delta

For the same reasons stated for the No Action Alternative LLT, EC levels (highs, lows, typical conditions) in the Sacramento River and its tributaries, the eastside tributaries, their associated reservoirs, and the San Joaquin River upstream of the Delta under Alternative 6A LLT are not expected to be outside the ranges occurring under existing conditions or would occur under the No Action Alternative NT and LLT. Any minor changes in EC levels that could occur under Alternative 6A LLT in water bodies upstream of the Delta would not be of sufficient magnitude, frequency and geographic extent that would cause adverse effects on beneficial uses or substantially degrade water quality with regard to EC.

Delta

Relative to existing conditions, Alternative 6A LLT would result in an increase in the number of days the Bay-Delta WQCP EC objectives for fish and wildlife protection (which apply during April and May) would be exceeded in the San Joaquin River at Jersey Point and Prisoners Point (Appendix H, Table EC-6). The percent of days the EC objective would be exceeded at Jersey Point for the entire period modeled (1976-1991) would increase from 0% under existing conditions to 3% under Alternative 6A LLT, and the percent of days out of compliance with the EC objective would increase from 0% under existing conditions to 5% under Alternative 6A LLT. The percent of days the EC objective would be exceeded at Prisoners Point for the entire period modeled would increase from 6% under existing conditions to 34% under Alternative 6A LLT, and the percent of days out of compliance with the EC objective would increase from 10% under existing conditions to 34% under Alternative 6A LLT. Average EC levels at the western and southern Delta compliance locations and San Joaquin River at San Andreas Landing (an interior Delta location) would decrease from 2-56% for the entire period modeled and 3-52% during the drought period modeled (1987-1991) (Appendix H, Table EC-17). In the S. Fork Mokelumne River at Terminous, average EC would increase 7% for the entire period modeled and 6% during the drought period modeled. Average EC in the S. Fork Mokelumne River at Terminous (an interior Delta location) would increase during all months (Appendix H, Table EC-17). The western Delta is Clean Water Act section 303(d) listed as impaired due to elevated EC, however, average EC for the entire period modeled would decrease 49-

52%. For the drought period modeled, average EC would decrease 46-52%. Thus, relative to existing conditions, Alternative 6A LLT would not contribute to additional impairment of section 303(d) listed waters.

Relative to the No Action Alternative NT, the change in percent compliance with Bay-Delta WQCP EC objectives under Alternative 6A LLT would be similar to that described above relative to existing conditions for the San Joaquin River at Jersey Point and Prisoners Point. In addition, there would also be a slight increase (1% or less) in the percent of days the EC objective would be exceeded in the San Joaquin River at Vernalis and Brandt Bridge, and Old River near Middle River for the entire period modeled. For the entire period modeled, average EC levels would increase at: S. Fork Mokelumne River at Terminous; San Joaquin River at Vernalis, Brandt Bridge, and Prisoners Point; and Old River at Middle River and at Tracy Bridge. The greatest average EC increase would occur in the S. Fork Mokelumne River at Terminous (7%); the average EC increase at the other locations would be 1-3% (Appendix H, Table EC-17). During the drought period modeled, average EC would increase at the same locations, except San Joaquin River at Prisoners Point. The greatest average EC increase during the drought period modeled would occur in the S. Fork Mokelumne River at Terminous (7%); the increase at the other locations would be 1% (Appendix H, Table EC-17). Given that the southern Delta is Clean Water Act section 303(d) listed as impaired due to elevated EC, the increase in the incidence of exceedance of EC objectives and increase in long-term and drought period average EC under Alternative 6A LLT at southern Delta compliance locations, relative to the No Action Alternative NT, has the potential to contribute to additional impairment and potentially adversely affect beneficial uses.

Relative to the No Action Alternative LLT, the locations with an increased frequency of exceedance of the Bay-Delta WQCP EC objectives under Alternative 6A LLT would be the same as those described above relative to existing conditions, plus the Old River at Tracy Bridge (Appendix H, Table EC-6). The change in percent of days exceeding EC objectives and percent of days out of compliance would also be similar to that described relative to existing conditions. The increase in the frequency of exceedance in Old River at Tracy Bridge would be <1%. Average EC would increase under Alternative 6A LLT relative to the No Action Alternative LLT similar to that described above relative to the No Action Alternative NT for the entire period modeled and drought period modeled (Appendix H, Table EC-17). Given that the southern Delta is Clean Water Act section 303(d) listed as impaired due to elevated EC, the increase in the incidence of exceedance of EC objectives and increase in long-term and drought period average EC under Alternative 6A LLT at southern Delta compliance locations, relative to the No Action Alternative LLT, has the potential to contribute to additional impairment and potentially adversely affect beneficial uses.

For Suisun Marsh, October-May is the period when Bay-Delta WQCP EC objectives for protection of fish and wildlife apply. Long-term average EC would increase under Alternative 6A LLT, relative to existing conditions, during the months of April and May by 0.2-0.4 mS/cm in the Sacramento River at Collinsville (Appendix H, Table EC-21). Long-term average EC would decrease relative to existing conditions in Montezuma Slough at National Steel during October-May (Appendix H, Table EC-22). The most substantial increase would occur near Beldon Landing, with long-term average EC levels increasing by 0.8-2.2 mS/cm, depending on the month, nearly doubling during some months the long-term average EC relative to existing conditions (Appendix H, Table EC-23). Sunrise Duck Club and Volanti Slough also would have long-term average EC increases during February-May of 0.4-1.7 mS/cm (Appendix H, Tables EC-24 and EC-25). The degree to which the long-term average EC increases would cause exceedance of Bay-Delta WQCP objectives is unknown, because objectives are expressed as a monthly average of daily high tide EC, which does not have to be met if it can be demonstrated "equivalent or better protection will be provided at the location" (State Water Resources Control Board 2006:14). The described long-term average EC increase may, or may not, contribute to adverse effects on beneficial uses, depending on how and when wetlands are flooded, soil leaching cycles, and how recirculation of water is managed, and future actions taken with respect to the marsh. However, the EC increases at certain locations would be substantial and it is uncertain the degree to which current management plans for the Suisun Marsh would be able to address these substantially higher EC levels and protect beneficial uses. Thus, these increased EC levels in Suisun Marsh are considered to have a potentially adverse effect on marsh beneficial uses. Long-term average EC increases in Suisun Marsh under Alternative 6A LLT relative to the No Action Alternative NT and LLT would be similar to the increases relative to existing conditions. Suisun Marsh also is section 303(d) listed as impaired due to elevated EC, and the potential increases in long-term average EC concentrations could contribute to additional impairment, because the increases would be double that relative to existing conditions and the No Action Alternative NT and LLT.

SWP/CVP Export Service Areas

At the Banks and Jones pumping plants, Alternative 6A LLT would result in no exceedances of the Bay-Delta WQCP's 1,000 µmhos/cm EC objective for the entire period modeled (Appendix H, Table EC-10). Thus, there would be no adverse effect to the beneficial uses in the SWP/CVP Export Service Areas using water pumped at this location under the Alternative 6A LLT.

At the Banks pumping plant, relative to existing conditions, average EC levels under Alternative 6A LLT would decrease substantially on average: 67% for the entire period modeled and 73% during the drought period modeled. Relative to the No Action Alternative NT, average EC levels would decrease by 64% for the entire period modeled and 71% during the drought period modeled. Similar decreases in average EC levels would occur relative to the No Action Alternative LLT. (Appendix H, Table EC-17)

At the Jones pumping plant, relative to existing conditions, average EC levels under Alternative 6A LLT would also decrease substantially: 68% for the entire period modeled and 74% during the drought period modeled. Relative to the No Action Alternative NT, average EC levels would decrease by 66% for the entire period modeled and 73% during the drought period modeled. Similar decreases in average EC levels would occur relative to the No Action Alternative LLT. (Appendix H, Table EC-17)

Based on the decreases in long-term average EC levels that would occur at the Banks and Jones pumping plants, Alternative 6A LLT would not cause degradation of water quality with respect to EC in the SWP/CVP Export Service Areas; rather, Alternative 6A LLT would improve long-term average EC conditions in the SWP/CVP Export Service Areas.

Commensurate with the EC decrease in exported waters, an improvement in lower San Joaquin River average EC levels would be expected since EC in the lower San Joaquin River is, in part, related to irrigation water deliveries from the Delta. While the magnitude of this expected lower San Joaquin River improvement in EC is difficult to predict, the relative decrease in overall loading of EC-elevating constituents to the Export Service Areas would likely alleviate or lessen any expected increase in EC at Vernalis related to decreased annual average San Joaquin River flows (see EC impact discussion under No Action Alternative LLT).

The export area of the Delta is listed on the state's CWA Section 303(d) list as impaired due to elevated EC. Alternative 6A LLT would result in lower average EC levels relative to existing conditions and the No Action Alternative NT and LLT and, thus, would not contribute to additional beneficial use impairment related to elevated EC in the SWP/CVP Export Service Areas waters.

***CEQA Conclusion*:** Relative to existing conditions, Alternative 6A LLT would not result in any substantial increases in long-term average EC levels upstream of the Delta or in the SWP/CVP Export Service Areas. In the Delta region, Alternative 6A LLT would result in an increase in the frequency with which Bay-Delta WQCP EC objectives for fish and wildlife protection are exceeded in the San Joaquin River at Jersey Point (from 0% under existing conditions to 3% under Alternative 6A LLT) and Prisoners Point (from 6% under existing conditions to 34% under Alternative 6A LLT) for the entire period modeled (1976-1991). Because EC is not bioaccumulative, the increases in long-term average EC levels would not directly cause bioaccumulative problems in aquatic life or humans. Portions of the Delta on the Clean Water Act section 303(d) list as impaired due to elevated EC would not have increased long-term average EC levels relative to existing conditions, Thus, alternative 6A LLT would not contribute to additional impairment of section 303(d) listed waters. The increased frequency of exceedance of fish and wildlife EC objectives at Prisoners Point could adversely affect aquatic life beneficial uses. This impact is considered to be potentially significant.

Further, relative to existing conditions, Alternative 6A LLT would result in substantial increases in long-term average EC during the months of October through May in Suisun Marsh, such that EC levels would nearly double that relative to existing conditions. The increases in long-term average EC levels that would occur in Suisun Marsh could further degrade existing EC levels and thus contribute additionally to adverse effects on the fish and wildlife beneficial uses. Because EC is not bioaccumulative, the increases in long-term average EC levels would not directly cause bioaccumulative problems in wildlife. Suisun Marsh is Clean Water Act section 303(d) listed for elevated EC and the increases in long-term average EC that would occur in the marsh could make beneficial use impairment measurably worse. This impact is considered to be potentially significant.

While Mitigation Measure WQ-11 may reduce these impacts, the feasibility and effectiveness of this mitigation measures is uncertain. Therefore, the available mitigation would not necessarily reduce the impact to a level that would be less than significant.

Mitigation Measure WQ-11: Reduce, avoid, and compensate for reduced water quality conditions

Please see Mitigation Measure WQ-11 under Impact WQ-11 in the discussion of Alternative 1A.

Impact WQ-12: Effects on electrical conductivity resulting from implementation of CM2-CM22

Effects of CM2-CM22 on EC under Alternative 6 LLT are the same as those discussed for Alternative 1A LLT. There would be no adverse effect. Under CEQA, this impact would be considered less than significant. No mitigation is required.

Impact WQ-13: Effects on mercury concentrations resulting from facilities operations and maintenance (CM1)

[*Note to Lead Agencies: This assessment is in preparation*].

Impact WQ-14: Effects on mercury concentrations resulting from implementation of CM2-CM22

[*Note to Lead Agencies: This assessment is in preparation*].

Impact WQ-15: Effects on nitrate concentrations resulting from facilities operations and maintenance (CM1)

Upstream of the Delta

For the same reasons stated for the No Action Alternative LLT, Alternative 6A LLT would have negligible, if any, impact on nitrate concentrations in the rivers and reservoirs upstream of the Delta in the Sacramento River watershed relative to existing conditions and the No Action Alternative NT and LLT.

Under Alternative 6A LLT, modeling indicates that long-term annual average flows on the San Joaquin River would decrease by an estimated 6%, relative to existing conditions, 5% relative to No Action NT, and would remain virtually the same relative to No Action LLT (crossreference to Modeling Data Appendix, CALSIM Flow Data for Vernalis). Given these relatively small decreases in flows and the weak correlation between nitrate and flows in the San Joaquin River (see Nitrate Appendix J Figure 2), it is expected that nitrate concentrations in the San Joaquin River will be minimally affected, if at all, by changes in flow rates under Alternative 6A LLT.

Any negligible changes in nitrate-N concentrations that may occur in the water bodies of the affected environment located upstream of the Delta would not be of frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the quality of these water bodies, with regards to nitrate.

Delta

Results of the mixing calculations indicate that under Alternative 6A LLT, relative to existing conditions, No Action NT, and No Action LLT, nitrate concentrations throughout the Delta are anticipated to remain low (<1.4 mg/L-N) relative to adopted objectives (Nitrate Appendix J Table 22 and 23). Long-term average nitrate concentrations are anticipated to increase at most locations in the Delta. The increase would be greatest at Franks Tract, Old River at Rock Slough, and Contra Costa Pumping Plant #1 (all >100% increase). Long-term average concentrations were estimated to increase to 0.78, 1.23 and 1.33 mg/L-N for Franks Tract, Old River at Rock Slough, and Contra Costa Pumping Plant #1, respectively, due primarily to increased San Joaquin River water percentage at these locations (see Fingerprinting Appendix D). Although changes at specific Delta locations and for specific months may be substantial on a relative basis, the absolute concentration of nitrate in Delta waters would remain low (<1.4 mg/L-N) in relation to the drinking water MCL of 10 mg/L-N, as well as all other thresholds identified in Table XX. No additional exceedances of the MCL are anticipated at any location (Nitrate Appendix J Table 22). On a monthly average basis and on a long term annual average basis, for all modeled years and for the drought period (1987-1991) only, use of assimilative capacity available under existing conditions, No Action NT, and No Action LLT, relative to the drinking water MCL of 10 mg/L-N, was up to approximately 14% at Old River at Rock Slough and Contra Costa Pumping Plant #1, and averaged approximately 8-9% on a long-term average basis(Nitrate Appendix J Table 24). Similarly, the use of available assimilative capacity at Franks Tract was up to approximately 7%, and averaged 4-5% over the long term. The concentrations estimated for these locations would not increase the likelihood of exceeding the 10 mg/L-N MCL, nor would they increase the risk for adverse effects to beneficial uses. At all other locations, use of assimilative capacity was negligible (<5%), except San Joaquin River at Buckley Cove in August, which showed a 7.3% use of the assimilative capacity that was available under the No Action Alternative LLT, for the drought period (1987-1991) (Nitrate Appendix J Table 24).

Nitrate concentrations will likely be higher than the modeling results indicate in certain locations, including: (1) in the Sacramento River between Freeport and Mallard Island and other areas in the Delta downstream of Freeport that are influenced by Sacramento River water, the increase becoming greater with increasing distance downstream, due to conversion of ammonia from the SRWTP discharge at Freeport (under existing conditions and No Action Alternative NT only, since upgrades to SRWTP that substantially reduce ammonia concentrations in the Sacramento River downstream of Freeport are assumed in the LLT; see the Ammonia section of this chapter for further discussion); (2) immediately downstream of wastewater treatment plants that practice nitrification, but not denitrification (e.g., City of Rio Vista Beach WWTF, Town of Discovery Bay WWTF, City of Stockton RWCF).

The effect of (1) (above) is expected to be small, on the order of 1 mg/L-N nitrate as N or less in the existing conditions and No Action Alternative NT. This is because the existing increase appears to be from approximately 0.1 mg/L-N to approximately 0.4-0.5 mg/L-N over this reach, due to approximately a 1:1 conversion of ammonia-N to nitrate-N (CVWQCB 2010:32). Because this nitrate is assumed not to be generated under Alternative 6A LLT, average concentrations would be expected to decrease under Alternative 6A LLT in this reach of the Sacramento River relative to existing conditions and the No Action Alternative NT. Regarding number (2) (above), for all such facilities in the Delta, the Regional Water Boards have issued NPDES permits that allow discharge of wastewater containing nitrate into the Delta, and under these permits, the State has determined that no beneficial uses are adversely affected by the discharge, and that the discharger's use of available assimilative capacity of the water body is acceptable. When dilution is necessary in order for the discharge to be in compliance with the Basin Plans (which incorporate the 10 mg/L-N MCL by reference), not all of the assimilative capacity of the receiving water is granted to the discharger. Thus, limited decreases in flows are not anticipated to result in systemic exceedances of the MCLs by these POTWs. Furthermore, NPDES permits are renewed on a 5-year basis, and thus, if under changes in flows, dilution was no longer sufficient to maintain nitrate below the MCL in the receiving water, the NPDES permit renewal process would address such cases.

Therefore, any increases in nitrate-N concentrations that may occur at certain locations within the Delta would not be of frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the water quality at these locations, with regards to nitrate.

SWP/CVP Export Service Areas

Assessment of effects of nitrate in the SWP and CVP Export Service Areas is based on effects on nitrate-N at the Banks and Jones pumping plants.

Results of the mixing calculations indicate that under Alternative 6A LLT, relative to existing conditions, No Action NT, and No Action LLT, nitrate concentrations at Banks and Jones pumping plants are anticipated to decrease on a long-term average annual basis, and on an average monthly basis for every month of the year (Nitrate Appendix J Table 22 and 23). No additional exceedances of the MCL are anticipated (Nitrate Appendix J Table 22). On a monthly average basis and on a long term annual average basis, for all modeled years and for the drought period (1987-1991) only, there was no use of assimilative capacity available under existing conditions and No Action NT, relative to the 10 mg/L-N MCL, for both Banks and Jones pumping plants (Nitrate Appendix J Table 24).

Therefore, implementation of this alternative is not expected to result in adverse effects to beneficial uses or substantially degrade the quality of exported water, with regards to nitrate.

***CEQA Conclusion*:** This alternative is not expected to cause additional exceedance of applicable water quality objectives/criteria by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. No long-term water quality degradation is expected to occur such that exceedance of criteria is more likely or such that there is an increased risk of adverse impacts to beneficial uses. Nitrate is not 303(d) listed within the affected environment and thus any increases than may occur in some areas and months would not make any existing nitrate-related impairment measurably worse because no such impairments currently exist. Because nitrate is not bioaccumulative, increases that may occur in some areas and months would not bioaccumulate to greater levels in aquatic organisms that would, in turn, pose substantial health risks to fish, wildlife, or humans. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-16: Effects on nitrate concentrations resulting from implementation of CM2-CM22

Effects of CM2–23 on nitrate under Alternative 6A LLT are the same as those discussed for Alternative 1A LLT. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-17: Effects on dissolved organic carbon concentrations resulting from facilities operations and maintenance (CM1)

Upstream of the Delta

Under Alternative 6A LLT, there would be no substantial change to the sources of DOC within the watersheds upstream of the Delta. Moreover, long-term average flow and DOC levels in the Sacramento River at Hood and San Joaquin River at Vernalis are poorlycorrelated. Thus changes in system operations and resulting reservoir storage levels and river flows would not be expected to cause a substantial long-term change in DOC concentrations in the water bodies upstream of the Delta. Any negligible changes in DOC levels in water bodies upstream of the Delta under Alternative 6A LLT, relative to existing conditions and the No Action Alternative NT and LLT, would not be of sufficient frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the quality of these water bodies, with regards to DOC.

Delta

Under Alternative 6A LLT, the geographic extent of effects pertaining to long-term average DOC concentrations in the Delta would be similar to that previously described for Alternative 1A LLT, although the magnitude of predicted long-term increase and relative frequency of concentration threshold exceedances would be substantially greater. Modeled effects would be greatest at Franks Tract, Rock Slough, and Contra Costa PP No. 1., where for the 16-year hydrologic period and the modeled drought period, long-term average concentration increases ranging from 1.0-1.6 mg/L would be predicted (≤46% net increase) resulting in long-term average DOC concentrations greater than 4 mg/L at all three Delta interior locations (Appendix 8K, DOC Table 7). Long-term average increases of 0.2-0.6 mg/L (≤20% net increase) would also occur at Staten Island, Emmaton, Antioch and Mallard Island. Increases in long-term average concentrations would correspond to more frequent concentration threshold exceedances, with the greatest change occurring at Rock Slough and Contra Costa PP No. 1 locations. For Rock Slough, long-term average DOC concentrations exceeding 3 mg/L would increase from 52% under existing conditions to 100% under the Alternative 6A LLT (an increase from 47% to 100% for the drought period), and concentrations exceeding 4 mg/L would increase from 30% to 79% (32% to 95% for the drought period). For Contra Costa PP No. 1, long-term average DOC concentrations exceeding 3 mg/L would increase from 52% under existing conditions to 100% under Alternative 6A LLT (45% to 100% for the drought period), and concentrations exceeding 4 mg/L would increase from 32% to 84% (35% to 95% for the drought period). Relative change in frequency of threshold exceedance for other assessment locations would be similar or less.

In comparison, Alternative 6A LLT relative to the No Action Alternative NT and No Action Alternative LLT would generally result in a similar magnitude of change to that discussed for the comparison to existing conditions. Maximum increases of 1.0 to 1.6 mg/L DOC (i.e., ≤46%) would be predicted at Franks Tract, Rock Slough, and Contra Costa PP No. 1 relative to No Action Alternative NT, while maximum increases at these locations would be slightly less (i.e., between 1.0 to 1.5 mg/L, ≤41%) when compared to No Action Alternative LLT (Appendix 8K, DOC Table 7). Threshold concentration exceedance frequency trends would also be similar to that discussed for the existing condition comparison, with exception to the predicted 4 mg/L exceedance frequency at Buckley Cove. In comparison to the No Action Alternative NT, the frequency which long-term average DOC concentrations exceeded 4 mg/L at Buckley Cove would increase from 23% to 30% (37% to 53% for the modeled drought period), with slightly smaller increases when comparing to No Action Alternative LLT.

The increases in long-term average DOC concentrations estimated to occur at Franks Tract, Rock Slough, and Contra Costa PP No. 1 are considered substantial and could potentially trigger significant changes in drinking water treatment plant design or operations. In particular, assessment locations at Rock Slough and Contra Costa PP No. 1 represent municipal intakes servicing existing drinking water treatment plants. Under Alternative 6A, drinking water treatment plants obtaining water from these interior Delta locations would likely need to upgrade existing treatment systems in order to achieve EPA Stage 1 Disinfectants and Disinfection Byproduct Rule action thresholds. While treatment technologies sufficient to achieve the necessary DOC removals exist, implementation of such technologies would likely require substantial investment in new or modified infrastructure.

Relative to existing, No Action Alternative NT, and No Action Alternative LLT conditions, Alternative 6A LLT would lead to predicted improvements in long-term average DOC concentrations at Barker Slough, Banks and Jones pumping plants. Predicted long-term average DOC concentrations at Barker Slough would decrease 0.1 mg/L (including the drought period), while long-term average DOC concentrations at Banks and Jones would decrease as much as 1.5-1.9 mg/L, depending on baseline conditions comparison and modeling period.

SWP/CVP Export Service Areas

Under Alternative 6A LLT, modeled long-term average DOC concentrations would decrease at Banks and Jones pumping plants for both the modeled 16-year hydrologic period and the modeled drought period. Modeled decreases would generally be similar between existing conditions, No Action Alternative NT, and No Action Alternative LLT. Relative to existing conditions, long-term average DOC concentrations at Banks would be predicted to decrease by 1.5 mg/L (1.8 mg/L during drought period) (Appendix 8K, DOC Table 7). At Jones, long-term average DOC concentrations would be predicted to decrease by 1.5 mg/L (1.7 mg/L during drought period). Such substantial improvement in long-term average DOC concentrations would include fewer exceedances of concentration thresholds. At both Banks and Jones, average DOC concentrations exceeding the 2 mg/L concentration threshold would decrease from 100% under existing conditions, No Action Alternative NT and No Action Alternative LLT to 39% under Alternative 6A (100% to 33% during the drought period), while concentrations exceeding 4 mg/L would nearly be eliminated (i.e., ≤10% exceedance frequency). Such modeled improvement would correspond to substantial improvement in Export Service Areas water quality, respective to DOC.

Similar to the discussion pertaining to the No Action Alternative LLT, maintenance of SWP and CVP facilities under Alternative 6A LLT would not be expected to create new sources of DOC or contribute towards a substantial change in existing sources of DOC in the affected area. Maintenance activities would not be expected to cause any substantial change in long-term average DOC concentrations such that MUN beneficial uses, or any other beneficial use, would be adversely affected.

CEQA Conclusion: Relative to existing conditions, Alternative 6A LLT operation and maintenance would not result in any substantial change in long-term average DOC concentration upstream of the Delta. Furthermore, under Alternative 6A LLT, water exported from the Delta to the SWP/CVP service area would be substantially improved relative to DOC. DOC is not bioaccumulative, therefore change in long-term average DOC concentrations would not directly cause bioaccumulative problems in aquatic life or humans. Additionally, DOC is not a constituent related to any 303(d) listings. Nevertheless, new and modified conveyance facilities proposed under Alternative 6A LLT would result in a substantial increase in long-term average DOC concentrations (i.e., 1.0-1.6 mg/L, equivalent to ≤46% relative increase) at Franks Tract, Rock Slough, and Contra Costa PP No.1. In particular, under Alternative 6A LLT, model predicted long-term average DOC concentrations would be greater than 4 mg/L at Rock Slough and Contra Costa PP No. 1 with commensurate substantial increases in the frequency with which average DOC concentrations exceed 2, 3, and 4 mg/L levels. Drinking water treatment plants obtaining water from these interior Delta locations would likely need to upgrade existing treatment systems in order to achieve EPA Stage 1 Disinfectants and Disinfection Byproduct Rule action thresholds. Therefore, such a magnitude change in long-term average DOC concentrations would represent a substantially increased risk for adverse effects on existing MUN beneficial uses at Rock Slough and Contra Costa PP No. 1 should such treatment upgrades not be undertaken. The impact is considered significant and mitigation is required. While Mitigation Measure WQ-17 is available to partially reduce this impact of DOC, the feasibility and effectiveness of this mitigation measures is uncertain and therefore it is not known if its implementation would reduce the identified impact to a level that would be less than significant.

Mitigation Measure WQ-17:

To reduce the effect of CM1 operations on increased DOC concentrations specifically predicted to occur at municipal water purveyors obtaining raw source water through south Delta intakes at Rock Slough and those associated with Contra Costa PP No. 1, DWR and Reclamation shall coordinate with the purveyors to identify the means to compensate for increases in long-term average DOC concentrations. DWR and Reclamation shall implement any combination of measures sufficient to maintaining DBP concentrations at existing levels (i.e., as system-wide running annual average) in treated drinking water of affected water purveyors. Such actions may include, but not be limited to, providing monetary compensation sufficient to: 1) upgrade and maintain adequate drinking water treatment systems, 2) develop or obtain replacement surface water supplies from other water rights holders, 3) develop replacement groundwater supplies, or 4) physically route a portion of the water diverted from the Sacramento River through the associated new conveyance pipelines/tunnel to affected purveyors.

Impact WQ-18: Effects on dissolved organic carbon concentrations resulting from implementation of CM2-CM22

Conservation components proposed under Alternative 6A would be the same as those proposed under Alternative 1A. As such, effects on DOC resulting from the implementation of CM2-CM22 would be similar to that previously discussed for Alternative 1A LLT, although the isolated conveyance facilities of Alternative 6A would effectively isolate SWP and CVP export facilities in the southern Delta from the influence of potential new or modified sources of DOC relative to conservation measures CM4-CM7 and C10. However, the potential for conservation measures CM4-CM7 and C10 to contribute substantial amounts of DOC to raw drinking water supplies to the other Delta municipal intakes would remain, and could possibly be measurably worse in actual comparison to the dual conveyance project alternatives. With relatively less low DOC Sacramento River water in the Delta, there effectively would be less dilution of interior Delta DOC sources, leading to effectively higher long-term average DOC concentrations. Substantially increased long-term average DOC in raw water supplies could lead to a need for treatment plant upgrades in order to appropriately manage DBP formation in treated drinking water. This potential for future DOC increases would lead to substantially greater associated risk of long-term adverse effects on the MUN beneficial use.

CEQA Conclusion: Effects of CM4-CM7 and CM10 on DOC under Alternative 6A LLT would be similar, and possibly greater, to those discussed for Alternative 1A LLT, except that SWP and CVP export facilities would be isolated from these effects by Alternative 6A design. Similar to the discussion for Alternative 1A, this impact is considered to be significant and mitigation is required. It is uncertain whether implementation of Mitigation Measure WQ-18 would reduce identified impacts to a less than significant level. Hence, this impact could remain significant after mitigation.

Mitigation Measure WQ-18: Design wetland and riparian habitat features to minimize effects on municipal intakes

Please see Mitigation Measure WQ-18 under Impact WQ-18 in the discussion of Alternative 1A.

Impact WQ-19: Effects on pathogens resulting from facilities operations and maintenance

Effects of CM1 on pathogens under Alternative 6A are the same as those discussed for Alternative 1A LLT. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-20: Effects on pathogens resulting from implementation of CM2–CM22

Effects of CM2–CM22on pathogens under Alternative 6A are the same as those discussed for Alternative 1A LLT. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-21: Effects on pesticide concentrations resulting from facilities operations and maintenance (CM1)

Upstream of the Delta

For the same reasons stated for the No Action Alternative LLT, under Alternative 6A LLT no specific operations or maintenance activity of the SWP or CVP would substantially drive a change in pesticide use, and thus pesticide sources would remain unaffected upstream of the Delta. Nevertheless, changes in the timing and magnitude of reservoir releases could have an effect on available dilution capacity along river segments such as the Sacramento, Feather, American, and San Joaquin Rivers.

Under Alternative 6A LLT, winter (November –March)and summer (April – October) season average flow rates on the Sacramento River at Freeport, American River at Nimbus, Feather River at Thermalito and the San Joaquin River at Vernalis would change. Relative to existing condition, No Action Alternative NT and No Action Alternative LLT, seasonal average flow rates on the Sacramento would decrease no more than 8% during the summer and 3% during the winter relative to existing conditions (Appendix 8L, Seasonal average flows Tables 1-4). On the Feather River, average flow rates would decrease no more than 7% during the summer, but would increase by as much as16% in the winter. American River average flow rates would decrease by as much as 17% in the summer but would increase by as much as 10% in the winter. Seasonal average flow rates on the San Joaquin River would decrease by as much as 12% in the summer, but increase by as much as 3% in the winter. For the same reasons stated for the No Action Alternative LLT, decreased seasonal average flow of ≤17% is not considered to be of sufficient magnitude to substantially increase pesticide concentrations or alter the long-term risk of pesticide-related toxicity to aquatic life, nor adversely affect other beneficial uses of water bodies upstream of the Delta.

Delta

Sources of diuron, OP and pyrethroid insecticides to the Plan Area include direct input of surface runoff from in-Delta agriculture and Delta urbanized areas as well inputs from rivers upstream of the Delta. Similar to Upstream of the Delta, CVP/SWP operations would not affect these sources.

Under Alternative 6A LLT, the distribution and mixing of Delta source waters would change. Percent change in monthly average source water fraction were evaluated for the modeled 16-year (1976-1991) hydrologic period and a representative drought period (1987-1991), with special attention given to changes in San Joaquin River, Sacramento River and Delta Agriculture sources water fractions. Relative to existing conditions, under Alternative 6A LLT modeled San Joaquin River fractions would increase greater than 10% at Buckley Cove (drought period only), Franks Tract, Rock Slough, Contra Costa PP No. 1, and the San Joaquin River at Antioch (Appendix 8D, Source Water Fingerprinting). At Buckley Cove, San Joaquin River source water fractions when modeled for the drought period would increase by 13% in July and 19% in August. At Antioch, San Joaquin River source water fractions when modeled for the 16-year hydrologic period would increase by 11-19% from October through June (11% for January through March of the modeled drought period). While these changes Buckley Cove and Antioch are not considered substantial, changes in San Joaquin River source water fraction in the Delta interior would be considerable. At Franks Tract, modeled San Joaquin River source water fractions would increase between 14-34% for the entire calendar year of January through December (12-28% for October through June of the modeled drought period). Changes at Rock Slough and Contra Costa PP No. 1 would be very similar, where modeled San Joaquin River source water fractions would increase from 26-76% (11-74% for the modeled drought period) for the entire calendar year. Relative to existing conditions, there would be no modeled increases in Sacramento River fractions greater than 14% (with exception to Banks and Jones which are discussed below) and Delta agricultural fractions greater than 11%. Increases in San Joaquin River source water fraction at Franks Tract, Rock Slough, and Contra Costa PP NO. 1 would primarily balance through decreases in Sacramento River water, and as a result the San Joaquin River would account for greater than 50% of the total source water volume at Franks Tract between March through May (<50% for all months during the modeled drought period), and would be 50%, and as much as 80% during October through May at Rock Slough and Contra Costa PP No. 1 for both the modeled drought and 16-year hydrologic periods. While the source water and potential pesticide related toxicity co-occurrence predictions do not mean adverse effect would occur, such considerable modeled increases in early summer source water fraction at Franks Tract and winter and summer source water fractions at Rock Slough and Contra Costa PP No. 1 could substantially alter the long-term risk of pesticide-related toxicity to aquatic life, given the apparent greater incidence of pesticides in the San Joaquin River.

When compared to No Action Alternative NT and No Action Alternative LLT, changes in source water fractions would be similar in season, geographic extent, and magnitude to those discussed for existing conditions with exception to Buckley Cove. At Buckley Cove, modeled San Joaquin River fractions would increase 20% in July (36% for the modeled drought period) and 27% (52% for the modeled drought period) in August when compared to No Action Alternative LLT (Appendix 8D, Source Water Fingerprinting). These increases would primarily balance through decreases in Sacramento River water and eastsidetributary waters, and as a result the San Joaquin River would account for as much as 77% of the total source water volume at Buckley Cove in July and August (as much as 64% for the modeled drought period). Relative to No Action Alternative LLT, the considerable modeled San Joaquin River source water fraction increases at Franks Tract, Rock Slough, Contra Costa PP No. 1, and Buckley Cove could substantially alter the long-term risk of pesticide-related toxicity to aquatic life, given the apparent greater incidence of pesticides in the San Joaquin River.

These predicted adverse effects on pesticides relative to existing conditions, No Action Alternative NT, and No Action Alternative LLT fundamentally assume that the present pattern of pesticide incidence in surface water will occur at similar levels into the future. In reality, however, the makeup and character of the pesticide use market in the late long-term (i.e., the year 2060) will not be exactly as it istoday. Current use of chlorpyrifos and diazinon is on the decline with their replacement by pyrethroids on the rise, yet in this assessment it is the apparent greater incidence of diazinon and chlorpyrifos on the San Joaquin River that serves as the basis for concluding that substantially increased San Joaquin River source water fraction would correspond to an increased risk of pesticide-related toxicity to aquatic life. By 2060, however, alternatives pesticides, such as neonicitinoids and biologicals, will likely be a more substantial contributing part of the existing mix of pesticides, and perhaps more prominent. The trend in the development of future-use pesticides is towards reduced risk pesticides, including more biopesticides, with greater targeted specificity, fewer residues, and lower overall non-target toxicity. By 2060 existing chlorpyrifos and diazinon TMDLs for the Sacramento and San Joaquin Rivers will have been in effect for more than 50 years. Moreover, it is reasonable to expect that CWA section 303(d) listings and future additional listings will have developed TMDLs by 2060. To the extent these existing and future TMDL's address current and future-use pesticides, a greater degree of pesticide related source control can be anticipated. Nevertheless, forecasting whether these various efforts will ultimately be successful at resolving current pesticide related impairments requires considerable speculation. While the fundamental assumptions that have guided this assessment of pesticides may be somewhat altered by 2060, these assumptions are informed by actual studies and monitoring data collected from the recent past and, therefore, judging project alternative effects in the future remain most accurate through use of these informed assumptions rather than based on assumptions founded upon future speculative conditions.

SWP/CVP Export Service Areas

Assessment of effects in SWP/CVP Export Service Areas is based on effects seen in the Plan Area at the Banks and Jones pumping plants. Under Alternative 6A LLT, Sacramento River source water fractions would increase substantially at both Banks and Jones pumping plants relative to existing conditions, No Action Alternative NT and No Action Alternative LLT (Appendix 8D, Source Water Fingerprinting). At Banks pumping plant, Sacramento source water fractions would generally increase from 19-79% for the entire period of January through December (12-56% for January through December of the modeled drought period) and at Jones pumping plant Sacramento source water fractions would generally increase from 33-96% for the entire period of January through December (17-89% for January through December of the modeled drought period). These increases in Sacramento source water fraction would primarily balance through equivalent decreases in San Joaquin River water. Based on the general observation that San Joaquin River, in comparison to the Sacramento River, is a greater contributor of OP insecticides in terms of greater frequency of incidence and presence at concentrations exceeding water quality benchmarks, modeled increases in Sacramento River fraction at Banks and Jones would generally represent an improvement in export water quality respective to pesticides.

***CEQA Conclusion*:** Relative to existing conditions, the Alternative 6A LLT would not result in any substantial change in long-term average pesticide concentration or result in substantial increase in the anticipated frequency with which long-term average pesticide concentrations would exceed aquatic life toxicity thresholds or other beneficial use effect thresholds upstream of the Delta or the SWP/CVP service area. Numerous pesticides are currently used throughout the affected environment, and while some of these pesticides may be bioaccumulative, those present-use pesticides for which there is sufficient evidence for their presence in waters affected by SWP and CVP operations (i.e., diazinon, chlorpyrifos, diuron, and pyrethroids) are not considered bioaccumulative, and thus changes in their concentrations would not directly cause bioaccumulative problems in aquatic life or humans. Furthermore, while there are numerous 303(d) listings throughout the affected environment that name pesticides as the cause for beneficial use impairment, the modeled changes in upstream river flows and Delta source water fractions would not be expected to make any of these beneficial use impairments measurably worse, with principal exception to locations in the Delta that would receive a substantially greater fraction San Joaquin River water under Alternative 6A. Long-term average San Joaquin River source water fractions at Buckley Cove, Franks Tract, Rock Slough and Contra Costa PP No. 1 locations would change considerably for some months such that the long-term risk of pesticide-related toxicity to aquatic life could substantially increase. Additionally, the potential for increased incidence of pesticide related toxicity could include pesticides such as chlorpyrifos and diazinon for which existing 303(d) listings exist for the Delta, and thus existing beneficial use impairment could be made discernibly worse. The impact is considered to be significant and unavoidable. There is no feasible mitigation available to reduce the effect of this significant impact.

Impact WQ-22: Effects on pesticide concentrations resulting from implementation of CM2–CM22

Conservation components proposed under Alternative 6A would be the same as those proposed under Alternative 1A. As such, effects on pesticides resulting from the implementation of CM2-CM22 would be similar to that previously discussed for Alternative 1A LLT. In summary, CM13 proposes the use of herbicides to control invasive aquatic vegetation around habitat restoration sites. Herbicides directly applied to water could include adverse effects on non-target aquatic life, such as aquatic invertebrates and beneficial aquatic plants. As such, aquatic life toxicity objectives could be exceeded with sufficient frequency and magnitude such that beneficial uses would be impacted.

CEQA Conclusion: Effects of CM2-2 CM2–CM22 on pesticides under Alternative 6A LLT are the similar as those discussed for Alternative 1A LLT. Potential environmental effects related only to CM13 are considered to be significant. Mitigation is required. While Mitigation Measure WQ-22 is available to partially reduce this impact of pesticides, no feasible mitigation is available that would reduce it to a level that would be less than significant.

Mitigation Measure WQ-22: Implement least toxic integrated pest management strategies

Please see Mitigation Measure WQ-22 under Impact WQ-22 in the discussion of Alternative 1A.

Impact WQ-23: Effects on phosphorus concentrations resulting from facilities operations and maintenance (CM1)

Effects of water facilities and operations (CM1) on phosphorus levels in water bodies of the affected environment under Alternative 3 LLT would be very similar (i.e., nearly the same) as those discussed for Alternative 1A LLT. Consequently, the environmental consequences to phosphorus levels discussed in detail for Alternative 1A LLT also adequately represent the effects under Alternative 3 LLT. Based on this finding, this impact is considered to be less than significant. No mitigation is required.

Impact WQ-24: Effects on phosphorus concentrations resulting from implementation of CM2–CM22

Effects of CM2–23 on phosphorus levels in water bodies of the affected environment under Alternative 6A LLT would be very similar (i.e., nearly the same) as those discussed for Alternative 1A LLT. Consequently, the environmental consequences to phosphorus levels from implementing CM2-CM22 discussed in detail for Alternative 1A LLT also adequately represent the effects of these same actions under Alternative 6A LLT. Based on this finding, this impact is considered to be less than significant. No mitigation is required.

Impact WQ-25: Effects on selenium concentrations resulting from facilities operations and maintenance (CM1)

[*Note to Lead Agencies: This assessment is in preparation*].

Impact WQ-26: Effects on selenium concentrations resulting from implementation of CM2–CM22

[*Note to Lead Agencies: This assessment is in preparation*].

Impact WQ-27: Effects on trace metal concentrations resulting from facilities operations and maintenance (CM1)

Upstream of the Delta

For the same reasons stated for the No Action Alternative LLT, Alternative 6A LLT would result in negligible, and likely immeasurable, increases in trace metal concentrations in the rivers and reservoirs upstream of the Delta, relative to existing conditions, No Action NT and No Action LLT.

Effects due to the operation and maintenance of the conveyance facilities are expected to be immeasurable, on an annual and long-term average basis. As such, the Alternative 6A would not be expected to substantially increase the frequency with which applicable Basin Plan objectives or CTR criteria would be exceeded in water bodies of the affected environment located upstream of the Delta or substantially degrade the quality of these water bodies, with regard to trace metals.

Delta

For the same reasons stated for the No Action Alternative LLT, Alternative 6A LLT would not result in substantial increases in trace metal concentrations in the Delta relative to existing conditions, No Action NT, and No Action LLT. However, substantial changes in source water fraction would occur in the south Delta (see Appendix D). Throughout much of the south Delta, San Joaquin River water would replace Sacramento River water, with the future trace metals profile largely reflecting that of the San Joaquin River. As discussed for the No Action Alternative, trace metal concentration profiles between the San Joaquin and Sacramento Rivers are very similar and currently meet Basin Plan objectives and CTR criteria. While the change in trace metal concentrations in the south Delta would likely be measurable, Alternative 6A would not be expected to substantially increase the frequency with which applicable Basin Plan objectives or CTR criteria would be exceeded in the Delta or substantially degrade the quality of Delta waters with regard to trace metals.

SWP/CVP Export Service Areas

For the same reasons stated for the No Action Alternative LLT, Alternative 6A LLT would not result in substantial increases in trace metal concentrations in SWP/CVP export service area waters under Alternative 6A, relative to existing conditions, No Action NT, and No Action LLT. Unlike current conditions, however, water delivered to the SWP and CVP export service area would be entirely sourced to the Sacramento River, and thus the future trace metals profile would reflect that of the Sacramento River. While the change in trace metal concentrations in SWP and CVP export service area would likely be measurable, Alternative 6A would not be expected to substantially increase the frequency with which applicable Basin Plan objectives or CTR criteria would be exceeded in the water bodies of the affected environment in the SWP/CVP service area or substantially degrade the quality of these water bodies, with regard to trace metals.

CEQA Conclusion: There would be no substantial long-term increase in trace metal concentrations in the rivers and reservoirs upstream of the Delta, in the Delta Region, or the SWP/CVP export service area waters under Alternative 6A relative to existing conditions. As such, this alternative is not expected to cause additional exceedance of applicable water quality objectives by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. Because trace metal concentrations are not expected to increase substantially, no long-term water quality degradation for trace metals is expected to occur and, thus, no adverse effects to beneficial uses would occur. Furthermore, any negligible changes in long-term trace metal concentrations that may occur in water bodies of the affected environment would not be expected to make any existing beneficial use impairments measurably worse. The trace metals discussed in this assessment are not considered bioaccumulative, and thus would not directly cause bioaccumulative problems in aquatic life or humans. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-28: Effects on trace metal concentrations resulting from implementation of CM2–CM22

Conservation components proposed under Alternative 6A would be the same as those proposed under Alternative 1A. As such, effects on trace metals resulting from the implementation of CM2-CM22 would be similar to that previously discussed for Alternative 1A. As they pertain to trace metals, implementation of CM2-CM22 would not be expected to adversely affect beneficial uses of the affected environment or substantially degrade water quality with respect to trace metals.

***CEQA Conclusion*:** Implementation of CM2-CM22 under Alternative 6A would not cause substantial long-term increase in trace metal concentrations in the rivers and reservoirs upstream of the Delta, in the Delta Region, or the SWP/CVP export service area. As such, this alternative is not expected to cause additional exceedance of applicable water quality objectives by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. Because trace metal concentrations are not expected to increase substantially, no long-term water quality degradation for trace metals is expected to occur and, thus, no adverse effects to beneficial uses would occur. Furthermore, any negligible changes in long-term trace metal concentrations that may occur throughout the affected environment would not be expected to make any existing beneficial use impairments measurably worse. The trace metals discussed in this assessment are not considered bioaccumulative, and thus would not directly cause bioaccumulative problems in aquatic life or humans. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-29: Effects on TSS and turbidity resulting from facilities operations and maintenance (CM1)

Effects of CM1 on TSS and turbidity under Alternative 6A are the same as those discussed for Alternative 1A LLT. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-30: Effects on TSS and turbidity resulting from implementation of CM2–CM22

Effects of CM2–CM22on TSS and turbidity under Alternative 6A are the same as those discussed for Alternative 1A LLT. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-31: Water quality impacts resulting from construction-related activities for CM1-CM22 implementation

The conveyance features for CM1 under Alternative 6A would be very similar to those discussed for Alternative 1A. The primary difference between Alternative 6A and Alternative 1A is that under Alternative 6A, there would be additional features constructed to create the isolated conveyance system. As such, construction techniques and locations of major features of the conveyance system within the Delta would be similar. The remainder of the facilities constructed under Alternative 6A, including conservation measures CM2-CM22, would be very similar to, or the same as, those to be constructed for Alternative 1A.

The types and magnitude of potential construction-related water quality effects associated with implementation of conservation measures CM1-CM22 under Alternative 6A would be very similar to the effects discussed for Alternative 1A LLT, and the effects anticipated with implementation of CM2-CM22 would be essentially identical. Nevertheless, the construction of CM1 with the environmental commitments and agency permitted construction requirements and BMPs would result in the potential water quality effects being largely avoided and minimized. The specific environmental commitments that would be implemented under Alternative 6A would be similar to those described for Alternative 1A (refer to Chapter 3, *Description of Alternatives*, for additional information regarding the environmental commitments and environmental permits). Consequently, relative to existing conditions, Alternative 6A LLT would not be expected to cause exceedance of applicable water quality objectives/criteria or substantial water quality degradation with respect to constituents of concern, and thus would not adversely affect any beneficial uses upstream of the Delta, in the Delta, or in the SWP and CVP service area.

CEQA Conclusion: Construction-related contaminant discharges would be temporary and intermittent in nature and would involve negligible, if any, discharges of bioaccumulative or 303(d) listed constituents to water bodies of the affected environment. As such, construction activities would not contribute measurably to bioaccumulation of contaminants in organisms or humans or cause 303(d) impairments to be discernibly worse. Because environmental commitments would be implemented under Alternative 6A LLT for construction-related activities along with agency-issues permits that also contain construction requirements to protect water quality, the construction-related effects would not be expected to cause or contribute to a substantial increased frequency of exceedances of water quality objectives/criteria relative to existing conditions, or substantially degrade water quality with respect to the constituents of concern on a long-term average basis, and thus would not adversely affect any beneficial uses in water bodies upstream of the Delta, within the Delta, or in the SWP and CVP service area. Based on these findings, this impact is determined to be less than significant. No mitigation is required.

8.3.4.10 Alternative 6B—Isolated Conveyance with East Canal and Intakes 1–5 (15,000 cfs; Operational Scenario D)

Alternative 6B would be identical to Alternative 6A except that the up to 15,000 cfs of water routed from the north Delta to the south Delta would be conveyed through a canal along the east side of the Delta instead of through pipelines/tunnels. CM2–CM22would be implemented under this alternative, and these conservation measures would be the same as those under Alternative 1A. See Chapter 3, *Description of Alternatives*, for additional details on Alternative 6B.

Water Quality Effects Resulting from Facilities Operations and Maintenance (CM1)

Alternative 6B has the same diversion and conveyance operations as Alternative 6A. The primary difference between the two alternatives is that conveyance under Alternative 6B would be in a lined or unlined canal, instead of pipeline. Because there would be no difference in conveyance capacity or operations, there would be no differences between these two alternatives in upstream of Delta river flows or reservoir operations, Delta inflow, source fractions to various Delta locations, and hydrodynamics in the Delta. Conveyance of water in an open channel instead of a pipeline may result in differing physical properties (e.g., DO, pH, temperature) of the water upon reaching the south Delta export pumps than if the water was conveyed in a pipeline. However, the physical properties of water arriving at the south Delta export pumps would continue to change and would equilibrate to similar levels as Alternative 6A as it is conveyed throughout the SWP/CVP Export Service Areas. Because no substantial differences in water quality effects are anticipated anywhere in the affected environment under Alternative 6B compared to those described in detail for Alternative 6A, the water quality effects described for Alternative 6A also appropriately characterize effects under Alternative 6B.

Water Quality Effects Resulting from Implementation of CM2–CM22

Alternative 6B has the same conservation measures as Alternative 6A. Because no substantial differences in water quality effects are anticipated anywhere in the affected environment under Alternative 6B compared to those described in detail for Alternative 6A, the water quality effects described for Alternative 6A also appropriately characterize effects under Alternative 6B.

Water Quality Effects Resulting from Construction

The primary difference between Alternative 6B and Alternative 1A is that under Alternative 6B, a canal would be constructed for conservation measure CM1 along the eastern side of the Delta to convey the Sacramento River water south, rather than the tunnel/pipeline features. As such, construction techniques and locations of major features of the conveyance system within the Delta would be different. The remainder of the facilities constructed under Alternative 6B, including conservation measures CM2-CM22, would be very similar to, or the same as, those to be constructed for Alternative 1A.

The types of potential construction-related water quality effects associated with implementation of conservation measures CM1 under Alternative 6B would be very similar to the effects discussed for Alternative 1A LLT, and the effects anticipated with implementation of CM2-CM22 would be essentially identical. Given the substantial differences in the conveyance features under CM1 with construction of canal, there could be differences in the location, magnitude, duration, and frequency of construction activities and related water quality effects. In particular, relative to the existing conditions and No Action Alternative conditions, construction of the major intakes and canal features for CM1 under Alternative 6B LLT would involve extensive general construction activities, material handling/storage/placement activities, surface soil grading/excavation/disposal and associated exposure of disturbed sites to erosion and runoff, and construction site dewatering operations. Nevertheless, the construction of CM1 with the environmental commitments and agency permitted construction requirements and BMPs would result in the potential water quality effects being largely avoided and minimized. The specific environmental commitments that would be implemented under Alternative 6B would be similar to those described for Alternative 1A. Consequently, relative to existing conditions, Alternative 6B LLT would not be expected to cause exceedance of applicable water quality objectives/criteria or substantial water quality degradation with respect to constituents of concern, and thus would not adversely affect any beneficial uses upstream of the Delta, in the Delta, or in the SWP and CVP service area.

8.3.4.11 Alternative 6C—Isolated Conveyance with West Canal and Intakes W1–W5 (15,000 cfs; Operational Scenario D)

Alternative 6C would be identical to Alternative 6A except that the up to 15,000 cfs of water routed from the north Delta to the south Delta would be conveyed through a canal/tunnel along the west side of the Delta instead of through pipelines/tunnels. CM2–CM22 would be implemented under this alternative, and these conservation measures would be the same as those under Alternative 1A. See Chapter 3, *Description of Alternatives,* for additional details on Alternative 6C.

Water Quality Effects Resulting from Facilities Operations and Maintenance (CM1)

Alternative 6C has the same diversion and conveyance operations as Alternative 6A. The primary differences between the two alternatives are that conveyance under Alternative 6C would be in a lined or unlined canal, instead of pipeline, and the alignment of the canal would be along the western side of the Delta, rather than the eastern side. Because there would be no difference in conveyance capacity or operations, there would be no differences between these two alternatives in upstream of Delta river flows or reservoir operations, Delta inflow, source fractions to various Delta locations, and hydrodynamics in the Delta. Conveyance of water in an open channel instead of a pipeline may result in differing physical properties (e.g., DO, pH, temperature) of the water upon reaching the south Delta export pumps than if the water was conveyed in a pipeline. However, the physical properties of water arriving at the south Delta export pumps would continue to change and would equilibrate to similar levels as Alternative 6A as it is conveyed throughout the SWP/CVP Export Service Areas. Because no substantial differences in water quality effects are anticipated anywhere in the affected environment under Alternative 6C compared to those described in detail for Alternative 6A, the water quality effects described for Alternative 6A also appropriately characterize effects under Alternative 6C.

Water Quality Effects Resulting from Implementation of CM2–CM22

Alternative 6C has the same conservation measures as Alternative 6A. Because no substantial differences in water quality effects are anticipated anywhere in the affected environment under Alternative 6C compared to those described in detail for Alternative 6A, the water quality effects described for Alternative 6A also appropriately characterize effects under Alternative 6C.

Water Quality Effects Resulting from Construction

The primary difference between Alternative 6C and Alternative 1A is that under Alternative 6C, a canal would be constructed for conservation measure CM1 along the western side of the Delta to convey the Sacramento River water south, in addition to the tunnel/pipeline features. As such, construction techniques and locations of major features of the conveyance system within the Delta would be different. The remainder of the facilities constructed under Alternative 6C, including conservation measures CM2-CM22, would be very similar to, or the same as, those to be constructed for Alternative 1A.

The types of potential construction-related water quality effects associated with implementation of conservation measures CM1 under Alternative 6C would be very similar to the effects discussed for Alternative 1A LLT, and the effects anticipated with implementation of CM2-CM22 would be essentially identical. Given the substantial differences in the conveyance features under CM1 with construction of canal in addition to the tunnel/pipeline features, there could be differences in the location, magnitude, duration, and frequency of construction activities and related water quality effects. In particular, relative to the existing conditions and No Action Alternative conditions, construction of the major intakes and canal features for CM1 under Alternative 6C LLT would involve extensive general construction activities, material handling/storage/placement activities, surface soil grading/excavation/disposal and associated exposure of disturbed sites to erosion and runoff, and construction site dewatering operations. Nevertheless, the construction of CM1 with the environmental commitments and agency permitted construction requirements and BMPs would result in the potential water quality effects being largely avoided and minimized. The specific environmental commitments that would be implemented under Alternative 6C would be similar to those described for Alternative 1A. However, this alternative would involve environmental commitments associated with both tunnel/pipeline and canal construction activities. Consequently, relative to existing conditions, Alternative 6C LLT would not be expected to cause exceedance of applicable water quality objectives/criteria or substantial water quality degradation with respect to constituents of concern, and thus would not adversely affect any beneficial uses upstream of the Delta, in the Delta, or in the SWP and CVP service area.

8.3.4.12 Alternative 7—Dual Conveyance with Tunnel, Intakes 2, 3, and 5, and Enhanced Aquatic Conservation (9,000 cfs; Operational Scenario E)

Alternative 7 would convey up to 9,000 cfs of water from the north Delta to the south Delta through pipelines/tunnels from three screened intakes on the east bank of the Sacramento River between Clarksburg and Walnut Grove. A new Byron Tract Forebay, adjacent to and south of Clifton Court Forebay, would be constructed which would provide water to the south Delta pumping plants. However, this would be an "isolated" conveyance, no longer involving operation of the existing SWP and CVP south Delta export facilities for Clifton Court Forebay and Jones Pumping Plant. Water supply and conveyance operations would follow the guidelines described as Scenario E, which includes fall X2. The modifications under this enhanced aquatic alternative are intended to further improve fish and wildlife habitat, especially along the San Joaquin River. Conservation measures 2-23 (CM2-23) would be implemented under this alternative, and would be the same as those under Alternative 1A, except that 40 linear miles rather than 20 linear miles of channel margin habitat would be enhanced, and 20,000 acres rather than 10,000 acres of seasonally inundated floodplain would be restored. See Chapter 3, *Description of Alternatives*, for additional details on Alternative 7.

Impact WQ-1: Effects on ammonia concentrations resulting from facilities operations and maintenance (CM1)

Upstream of the Delta

For the same reasons stated for the No Action Alternative LLT, Alternative 7 LLT would have negligible, if any, effect on ammonia concentrations in the rivers and reservoirs upstream of the Delta relative to existing conditions and the No Action Alternative NT and LLT. Any negligible increases in ammonia-N concentrations that could occur in the water bodies of the affected environment located upstream of the Delta would not be of frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the quality of these water bodies, with regard to ammonia.

Delta

Assessment of effects of ammonia under Alternative 7 LLT is the same as discussed under Alternative 1A, except that because flows in the Sacramento River at Freeport are different between the two alternatives, estimated monthly average and long term annual average predicted ammonia-N concentrations in the Sacramento River downstream of Freeport are different.

As Table 8-60 shows, estimated ammonia-N concentrations in the Sacramento River downstream of Freeport (upon full mixing of the SRWTP discharge with river water) under Alternative 7 LLT and the No Action Alternative LLT are expected to be similar. Minor increases in ammonia-N concentrations would occur during July through September, November through January, and in April, and remaining months would be unchanged or have a minor decrease. Annual average concentrations would be the same under both Alternative 7 LLT and the No Action Alternative LLT. Moreover, the estimated concentrations downstream of Freeport under Alternative 7 LLT would be similar to existing source water concentrations for the San Francisco Bay and San Joaquin River.

Consequently, changes in source water fraction anticipated under Alternative 7 LLT, relative to the No Action Alternative LLT, are not expected to substantially increase ammonia concentrations at any Delta locations.

Table 8-60. Estimated Ammonia-N (mg-L as N) Concentrations in the Sacramento River Downstream of the Sacramento Regional Wastewaster Treatment Plant for the No Action Alternative LLT and Alternative 7 LLT

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual Average
No Action Alternative LLT	0.081	0.073	0.061	0.055	0.053	0.055	0.061	0.070	0.072	0.064	0.072	0.069	0.063
Alternative 7 LLT	0.080	0.075	0.063	0.056	0.053	0.056	0.062	0.069	0.070	0.065	0.074	0.071	0.063

Any negligible increases in ammonia-N concentrations that could occur at certain locations in the Delta would not be of frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the water quality at these locations, with regards to ammonia.

SWP/CVP Export Service Areas

The assessment of effects on ammonia in the SWP/CVP Export Service Area is based on assessment of ammonia-N concentrations at Banks and Jones pumping plants. Similar to the discussion for Alternative 1A, under Alternative 7 for areas of the Delta that are influenced by Sacramento River water, including Banks and Jones pumping plants, ammonia-N concentrations are expected to decrease, relative to existing conditions and No Action Alternative NT. This decrease in ammonia-N concentrations for water exported via the south Delta pumps is not expected to result in an adverse effects on beneficial uses or substantially degrade water quality of exported water, with regards to ammonia.

Furthermore, as discussed above for the Plan Area, for all areas of the Delta, including Banks and Jones pumping plants, ammonia-N concentrations are not expected to be substantially different under Alternative 7 LLT, relative to No Action Alternative LLT. Any negligible increases in ammonia-N concentrations that could occur at Banks and Jones pumping plants would not be of frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the water quality at these locations, with regards to ammonia.

***CEQA Conclusion*:** There would be no substantial, long-term increase in ammonia-N concentrations in the rivers and reservoirs upstream of the Delta, in the PlanArea, or the waters exported to the CVP and SWP service areas under Alternative 7 LLT relative to existing conditions. As such, this alternative is not expected to cause additional exceedance of applicable water quality objectives/criteria by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. Because ammonia concentrations are not expected to increase substantially, no long-term water quality degradation is expected to occur and, thus, no adverse effects on beneficial uses would occur. Ammonia is not 303(d) listed within the affected environment and thus any minor increases than could occur in some areas would not make any existing ammonia-related impairment measurably worse because no such impairments currently exist. Because ammonia-N is not bioaccumulative, minor increases that could occur in some areas would not bioaccumulate to greater levels in aquatic organisms that would, in turn, pose substantial health risks to fish, wildlife, or humans. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-2: Effects on ammonia concentrations resulting from implementation of CM2–CM22

Effects of CM2–23 on ammonia under Alternative 7 LLT are the same as those discussed for Alternative 1A LLT. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-3:Effects on boron concentrations resulting from facilities operations and maintenance (CM1)

Upstream of the Delta

Effects of CM1 on boron under Alternative 7A LLT in areas upstream of the Delta would be very similar to the effects discussed for Alternative 1A LLT. There would be no expected change to the sources of boron in the Sacramento and east-side tributary watersheds, and resultant changes in flows from altered system-wide operations would have negligible, if any, effects on the concentration of boron in the rivers and reservoirs of these watersheds. The modeled long-term annual average lower San Joaquin River flow at Vernalis would decrease slightly compared to existing conditions and the No Action Alternative NT, and would be similar compared to the No Action Alternative LLT. The reduced flow would result in possible increases in long-term average boron concentrations of up to about 3% relative to the existing conditions and No Action Alternative NT conditions. The increased boron concentrations would not increase the frequency of exceedances of any applicable objectives or criteria and would not be expected to cause further degradation at measurable levels in the lower San Joaquin River, and thus would not cause the existing impairment there to be discernibly worse. Consequently, Alternative 7A LLT would not be expected to cause exceedance of boron objectives/criteria or substantially degrade water quality with respect to boron, and thus would not adversely affect any beneficial uses of the Sacramento River, the east-side tributaries, associated reservoirs upstream of the Delta, or the San Joaquin River.

Delta

Effects of CM1 on boron under Alternative 7A LLT in the Delta would be very similar to the effects discussed for Alternative 1A LLT. Relative to the existing conditions, No Action Alternative NT, and No Action Alternative LLT, Alternative 7A LLT would result in increased long-term average boron concentrations for the 16-year period modeled at interior and western Delta locations (by as much as 10% at the SF Mokelumne River at Staten Island, 33% at Franks Tract, 56% at Old River at Rock Slough, and 2% at the Sacramento River at Emmaton) (Appendix 8F, Table Bo-18). Implementation of tidal habitat restoration under conservation measure CM4 also may contribute to increased boron concentrations at western Delta assessment locations, and thus would not be anticipated to substantially affect agricultural diversions which occur primarily at interiorDelta locations. The long-term annual average and monthly average boron concentrations, for either the 16-year period or drought period modeled, would never exceed the 2,000 μg/L human health advisory objective (i.e., for children) or 500 μg/L agricultural objective at any of the eleven Delta assessment locations, which represents no change from the existing conditions and No Action Alternative NT and LLT conditions (Appendix 8F, Table Bo-3). The increased concentrations at interior Delta locations would result in moderate reductions in the long-term average assimilative capacity of up to 18% at Franks Tract and up to 33% at Old River at Rock Slough locations (Appendix 8F, Table Bo-19). However, because the absolute boron concentrations would still be well below the lowest 500 μg/L objective for the protection of the agricultural beneficial use under Alternative 7A LLT, the levels of boron degradation would not be of sufficient magnitude to substantially increase the risk of exceeding objectives or cause adverse effects to municipal and agricultural water supply beneficial uses, or any other beneficial uses, in the Delta (Appendix 8F, Figure Bo-4).

SWP/CVP Export Service Areas

Effects of CM1 on boron under Alternative 7A LLT in the Delta would be very similar to the effects discussed for Alternative 1A LLT. Under Alternative 7A LLT, long-term average boron concentrations would decrease by as much as 41% at the Banks Pumping Plant and by as much 48% at Jones Pumping Plant relative to existing conditions, No Action Alternative NT, and No Action Alternative LLT (Appendix 8F, Table Bo-18). Commensurate with the decrease in exported boron concentrations, boron concentrations in the lower San Joaquin River may be reduced and would likely alleviate or lessen any expected increase in boron concentrations at Vernalis associated with flow reductions (see discussion of Upstream of the Delta), as well locations in the Delta receiving a large fraction of San Joaquin River water. Reduced export boron concentrations also may contribute to reducing the existing 303(d) impairment in the lower San Joaquin River and associated TMDL actions for reducing boron loading.

Maintenance of SWP and CVP facilities under Alternative 7A LLT would not be expected to create new sources of boron or contribute towards a substantial change in existing sources of boron in the affected environment. Maintenance activities would not be expected to cause any substantial increases in boron concentrations or degradation with respect to boron such that objectives would be exceeded more frequently, or any beneficial uses would be adversely affected anywhere in the affected environment.

***CEQA Conclusion*:** Boron is not a bioaccumulative constituent, thus any increased concentrations under Alternative 7A LLT would not result in adverse boron bioaccumulation effects to aquatic life or humans. Relative to existing conditions, Alternative 7A LLT would not result in any substantial increases in boron concentration upstream of the Delta. Alternative 7A LLT maintenance also would not result in any substantial increases in boron concentrations in the affected environment. Relative to existing conditions, Alternative 7A LLT would not result in substantially increased boron concentrations such that frequency of exceedances of municipal and agricultural water supply objectives would increase. The levels of boron degradation that may occur under Alternative 7A LLT, while widespread in particular at interior Delta locations, would not be of sufficient magnitude to cause substantially increased risk for adverse effects to municipal or agricultural beneficial uses within the affected environment. Long-term average boron concentrations would decrease in Delta water exports to the SWP and CVP service area, which may contribute to reducing the existing 303(d) impairment of agricultural beneficial uses in the lower San Joaquin River. Consequently, Alternative 7A LLT would not be expected to cause any substantial increases in boron concentrations or degradation with respect to boron such that objectives would be exceeded more frequently, or any beneficial uses would be adversely affected anywhere in the affected environment. Based on these findings, this impact is determined to be less than significant. No mitigation is required.

Impact WQ-4: Effects on boron concentrations resulting from implementation of CM2–CM22

Effects of CM2-CM22 on boron under Alternative 7A LLT are the same as those discussed for Alternative 1A LLT. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-5: Effects on bromide concentrations resulting from facilities operations and maintenance (CM1)

Upstream of the Delta

Under Alternative 7 LLT there would be no expected change to the sources of bromide in the Sacramento and eastside tributary watersheds. Bromide loading in these watersheds would remain unchanged and resultant changes in flows form altered system-wide operations under Alternative 7 LLT would have negligible, if any, effects on the concentration of bromide in the rivers and reservoirs of these watersheds. Consequently, Alternative 7 LLT would not be expected to adversely affect the MUN beneficial use, or any other beneficial uses, of the Sacramento River, the eastside tributaries, or their associated reservoirs upstream of the Delta.

Under Alternative 7 LLT, modeling indicates that long-term annual average flows on the San Joaquin River would decrease by 6%, relative to existing conditions, 5% relative to No Action Alternative NT, and would remain virtually the same relative to No Action Alternative LLT. Similar to the No Action Alternative LLT, these decreases in flow would result in possible increase in long-term average bromide concentrations of about 3%, relative to existing conditions, 2% relative to No Action Alternative NT, and less than <1% relative to No Action Alternative LLT. The small increases in lower San Joaquin River bromide levels that could occur under Alternative 7 LLT, relative to existing, No Action Alternative NT, and No Action Alternative LLT conditions would not be expected to adversely affect the MUN beneficial use, or any other beneficial uses, of the lower San Joaquin River.

Delta

Relative to existing conditions, Alternative 7 LLT would result in increases in long-term average bromide concentrations at Staten Island and Barker Slough (for the modeled drought period only), while long-term average concentrations would decrease at the other assessment locations (Appendix 8E, Bromide Table 16-17). At Barker Slough, predicted long-term average bromide concentrations would decrease from 51 μg/L to 50 μg/L (2% relative decrease) for the modeled 16-year hydrologic period, but would increase from 54 μg/L to 72 μg/L (34% relative increase) for the modeled drought period. At Barker Slough, the predicted 50 μg/L exceedance frequency would decrease from 49% under existing conditions to 29% under Alternative 7 LLT, but would increase slightly from 55% to 57% during the drought period. At Barker Slough, the predicted 100 μg/L exceedance frequency would increase from 0% under existing conditions to 8% under Alternative 7 LLT, and would increase from 0% to 22% during the drought period. At Staten Island, predicted long-term average bromide concentrations would increase from 50 μg/L to 63 μg/L (27% relative increase) for the modeled 16-year hydrologic period and would increase from 51 μg/L to 64 μg/L (25% relative increase) for the modeled drought period. At Staten Island, increases in average bromide concentrations would correspond to an increased frequency of 50 ug/l threshold exceedance, from 47% under existing conditions to 80% under Alternative 7 LLT (52% to 88% for the modeled drought period), and an increase from 1% to 2% (0% to 0% for the modeled drought period) for the 100 μg/L threshold. Changes in exceedance frequency of the 50 μg/L and 100 μg/L concentration thresholds at other assessment locations would be less considerable, with exception to Franks Tract. Although long-term average bromide concentrations were modeled to decrease at Franks Tract, exceedances of the 100 µg/L threshold would increase slightly, from 82% under existing conditions to 99% under Alternative 7 LLT (78% to 97% for the modeled drought period).

Due to the relatively small differences between modeled existing conditions and No Action baselines, changes in long-term average bromide concentrations and changes in exceedance frequencies relative to No Action Alternative NT and No Action Alternative LLT are generally of similar magnitude to those previously described for the existing condition comparison (Appendix 8E, Bromide Table 16-17). Modeled long-term average bromide concentration at Barker Slough is predicted to increase by 3% (37% for the modeled drought period) relative to No Action Alternative NT, and would increase by 1% (34% for the modeled drought period) relative to No Action Alternative LLT. Modeled long-term average bromide concentration increases at Staten Island are predicted to increase by 26% (25% for the modeled drought period) relative to No Action Alternative NT, and would increase by 31% (29% for the modeled drought period) relative to No Action Alternative LLT. However, unlike the existing conditions comparison, long-term average bromide concentrations at Buckley Cove would increase relative to No Action Alternative NT and No Action Alternative LLT, although the increases would be relatively small (≤9%).

While the increase in long-term average bromide concentrations at Barker Slough are relatively small when modeled over a representative 16-year hydrologic period, increases during the modeled drought period, principally the relative increase in 100 µg/L exceedance frequency, would represent a substantial change in source water quality during a season of drought. As discussed for Alternative 1A, drinking water treatment plants obtaining water via the North Bay Aqueduct utilize a variety of conventional and enhanced treatment technologies in order to achieve DBP drinking water criteria. While the implications of such a modeled drought period change in bromide concentrations at Barker Slough is difficult to predict, the substantial modeled increases could lead to adverse changes in the formation of disinfection byproducts such that considerable treatment plant upgrades may be necessary in order to achieve equivalent levels of health protection during seasons of drought. Increases at Staten Island are also considerable, although there are no existing or foreseeable municipal intakes in the immediate vicinity.

The seasonal intakes at Mallard Slough and City of Antioch are infrequently used due to water quality constraints related to sea water intrusion. On a long-term average basis, bromide at these locations is in excess of 3,000 µg/L, but during seasonal periods of high Delta outflow can be <300 µg/L. Use of the seasonal intakes at Mallard Slough and City of Antioch under Alternative 7 LLT would experience a period average increase in bromide during the months when these intakes would most likely be utilized. For those wet and above normal water year types where mass balance modeling would predict water quality typically suitable for diversion, predicted long-term average bromide would increase from 103 µg/L to 152 µg/L (48% increase) at City of Antioch and would increase from 150 µg/L to 204 µg/L (36% increase) at Mallard Slough relative to existing conditions (Appendix 8E, Bromide Figure 6-7). Increases would be similar for No Action Alternative NT and No Action Alternative LLT comparison. The decisions surrounding the use of these seasonal intakes is largely driven by acceptable water quality, and thus have historically been opportunistic. Opportunity to use these intakes would remain, and the predicted increases in bromide concentrations at the City of Antioch and Mallard Slough intake would not be expected to adversely affect MUN beneficial uses, or any other beneficial use, at these locations.

Relative to existing, No Action Alternative NT, and No Action Alternative LLT conditions, Alternative 7 LLT would lead to predicted improvements in long-term average bromide concentrations at

Franks Tract, Rock Slough, and Contra Costa PP No. 1, in addition to Banks and Jones (discussed below). At these locations, long-term average bromide concentrations would be predicted to decrease by as much as 16-32%, depending on baseline comparison.

SWP/CVP Export Service Areas

Under Alternative 7 LLT, improvement in long-term average bromide concentrations would occur at the Banks and Jones pumping plants. Long-term average bromide concentrations for the modeled 16-year hydrologic period at these locations would decrease by as much as 71% relative to existing conditions, 69% relative to No Action Alternative NT, and 67% relative to No Action Alternative LLT (Appendix 8E, Bromide Tables 16-17). As a result, exceedances of the 50 μg/L and 100 μg/L assessment thresholds would be substantially reduced, resulting in considerable overall improvement in Export Service Areas water quality respective to bromide. Commensurate with the decrease in exported bromide, an improvement in lower San Joaquin River bromide would also be observed since bromide in the lower San Joaquin River is principally related to irrigation water deliveries from the Delta. While the magnitude of this expected lower San Joaquin River improvement in bromide is difficult to predict, the relative decrease in overall loading of bromide to the Export Service Areas would likely alleviate or lessen any expected increase in bromide concentrations at Vernalis (see discussion of Upstream of the Delta) as well locations in the Delta receiving a large fraction of San Joaquin River water, such as much of the south Delta.

Similar to the discussion pertaining to the No Action Alternative LLT, maintenance of SWP and CVP facilities under Alternative 7 LLT would not be expected to create new sources of bromide or contribute towards a substantial change in existing sources of bromide in the affected environment. Maintenance activities would not be expected to cause any substantial change in bromide such that MUN beneficial uses, or any other beneficial use, would be adversely affected anywhere in the affected environment.

CEQA Conclusion: Relative to existing conditions, Alternative 7 LLT operation and maintenance would not result in any substantial change in long-term average bromide concentration upstream of the Delta. Furthermore, under Alternative 7 LLT, water exported from the Delta to the SWP/CVP service area would be substantially improved relative to bromide. Bromide is not bioaccumulative, therefore change in long-term average bromide concentrations would not directly cause bioaccumulative problems in aquatic life or humans. Additionally, bromide is not a constituent related to any 303(d) listings. Alternative 7 LLT operation and maintenance activities would not cause substantial long-term degradation to water quality respective to bromide with the exception of water quality at Barker Slough (drought period only) and at Staten Island in the eastern Delta. There are no existing or foreseeable municipal intakes in the vicinity of Staten Island, but Barker Slough is the source of the North Bay Aqueduct. At Barker Slough, modeled long-term annual average concentrations of bromide would increase by 34% during the modeled drought period. For the modeled 1drought period the frequency of predicted bromide concentrations exceeding 100 μg/L would increase from 0% under existing conditions to 22% under Alternative 7 LLT. Substantial changes in long-term average bromide during seasons of drought could necessitate changes in treatment plant operation or require treatment plant upgrades in order to maintain DBP compliance. The model predicted change at Barker Slough during the drought period is substantial and, therefore, would represent a substantially increased risk for adverse effects on existing MUN beneficial uses should treatment upgrades not be undertaken. The impact is considered significant and mitigation is required. Implementation of Mitigation Measure WQ-5 would reduce identified impacts to a less than significant level by relocating the North Bay Aqueduct outside the influence of sea water intrusion.

Mitigation Measure WQ-5: Move the North Bay Aqueduct intake from Barker Slough to the Sacramento River

Please see Mitigation Measure WQ-5 under Impact WQ-5 in the discussion of Alternative 1A.

Impact WQ-6: Effects on bromide concentrations resulting from implementation of CM2–CM22

Conservation components under Alternative 7 would be similar to those under Alternative 1A, but 40 linear miles rather than 20 linear miles of channel margin habitat would be enhanced, and 20,000 acres rather than 10,000 acres of seasonally inundated floodplain would be restored. As discussed for Alternative 1A LLT, implementation of the CM2-CM22 would not present new or substantially changed sources of bromide to the project area. Some conservation measures may replace or substitute for existing irrigated agriculture in the Delta. This replacement or substitution is not expected to substantially increase or present new sources of bromide. CM2-CM22 would not be expected to cause any substantial change in bromide such that MUN beneficial uses, or any other beneficial use, would be adversely affected anywhere in the affected environment.

***CEQA Conclusion*:** Conservation components proposed under Alternative 7 LLT would be similar to those proposed under Alternative 1A LLT. As discussed for Alternative 1A LLT, implementation of CM2-CM22 would not present new or substantially changed sources of bromide to the project area. As such, effects on bromide resulting from the implementation of CM2-CM22 would be similar to that previously discussed for Alternative 1A LLT. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-7: Effects on chloride concentrations resulting from facilities operations and maintenance (CM1)

Upstream of the Delta

Under Alternative 7A LLT there would be no expected change to the sources of chloride in the Sacramento and eastside tributary watersheds. Chloride loading in these watersheds would remain unchanged and resultant changes in flows from altered system-wide operations would have negligible, if any, effects on the concentration of chloride in the rivers and reservoirs of these watersheds. The modeled long-term annual average flows on the lower San Joaquin River at Vernalis would decrease slightly compared to existing conditions and the No Action Alternative NT, and be similar compared to the No Action Alternative LLT. The reduced flow would result in possible increases in long-term average chloride concentrations of about 2%, relative to the existing conditions and No Action Alternative NT conditions, and no change relative to No Action Alternative LLT. Consequently, Alternative 7A LLT would not be expected to cause exceedance of chloride objectives/criteria or substantially degrade water quality with respect to chloride, and thus would not adversely affect any beneficial uses of the Sacramento River, the eastside tributaries, associated reservoirs upstream of the Delta, or the San Joaquin River.

Delta

Relative to the existing conditions, No Action Alternative NT, and No Action Alternative LLT, Alternative 7A LLT would result in similar or reduced long-term average chloride concentrations for the 16-year period modeled at nine of the assessment locations, and increased concentrations at the North Bay Aqueduct at Barker Slough (up to 31% compared to No Action Alternative LLT) and San Joaquin River at Staten Island (up to 28% compared to No Action Alternative NT) (Appendix 8G, Chloride Table Cl-29). Moreover, the direction and magnitude of predicted changes for Alternative 7A LLT are similar between the alternatives, thus, the effects relative to existing conditions and the No Action Alternative scenarios are discussed together. Additionally, implementation of tidal habitat restoration under conservation measure CM4 would increase the tidal exchange volume in the Delta, and thus may contribute to increased chloride concentrations in the Bay source water as a result of increased salinity intrusion. Consequently, while uncertain, the magnitude of chloride increases may be greater than indicated herein and would affect the western Delta assessment locations the most which are influenced to the greatest extent by the Bay source water. The following outlines the modeled chloride changes relative to the applicable objectives and beneficial uses of Delta waters.

Municipal Beneficial Uses

Relative to the 150 mg/L Bay-Delta WQCP objective for municipal and industrial beneficial uses, the plots of monthly average chloride concentrations at the Contra Costa Canal at Pumping Plant #1 for the separate water year types indicates that the number of months above the objective would remain unchanged or decrease compared to the existing conditions (Appendix 8G, Figure Cl-11). The modeled chloride concentrations at the San Joaquin River at Antioch location would never meet this objective; however, this represents no change from the existing conditions, No Action Alternative NT, and No Action Alternative LLT.

With respect to the 250 mg/L Bay-Delta WQCP objective, the modeled frequency of exceedances based on monthly average chloride concentrations would decrease up to 12% (i.e., 24% for existing conditions to 12%) at the Contra Costa Canal at Pumping Plant #1 (Appendix 8G, Table Cl-30 and Figure Cl-12). The frequency of exceedances would decrease at the San Joaquin River at Antioch (i.e., from 66% under existing conditions to 60%) with no substantial change predicted for Mallard Island (i.e., maximum increase of 1%) (Appendix 8G, Table Cl-30) and no substantial long-term degradation (Appendix 8G, Table Cl-31). Consequently, Alternative 7A LLT would result in improved chloride conditions with respect to municipal and industrial beneficial uses.

Aquatic Life Beneficial Uses

Relative to the 230 mg/L chronic EPA aquatic life criterion, monthly average chloride concentrations would not exceed the criterion at northern and eastern Delta locations, and the frequency of exceedances would decrease at the interior and southern Delta locations compared to the existing conditions, No Action Alternative NT, and No Action Alternative LLT (Appendix 8G, Table Cl-30). However, substantial reductions in assimilative capacity would occur compared to existing conditions in August and October at Franks Tract (i.e., up to 100%, or elimination) and in August and September at Old River at Rock Slough (i.e., up to 100%) (Appendix 8G, Table Cl-32) when concentrations would be near, or exceed, the criterion (Appendix 8G, Figure Cl-13), thus indicating the potential for increased frequency of exceedances and adverse effects on aquatic life beneficial uses.

303(d) Listed Water Bodies

With respect to the 303(d) listing for chloride in Tom Paine Slough, the monthly average chloride concentrations for the 16-year period modeled at Old River at Tracy Road would generally be similar compared to existing conditions, and thus, would not be further degraded on a long-term basis (Appendix 8G, Figure Cl-13). With respect to Suisun Marsh, the monthly average chloride concentrations for the 16-year period modeled would generally increase compared to existing conditions in some months during October through May at the Sacramento River at Collinsville (Appendix 8G, Figure Cl-14), Mallard Island (Appendix 8G, Figure Cl-12), and increase substantially at Montezuma Slough at Beldon's Landing (i.e., over a doubling of concentration in December through February) (Appendix 8G, Figure Cl-15), thereby contributing to additional, measureable long-term degradation that potentially would adversely affect the necessary actions to reduce chloride loading for any TMDL that is developed.

SWP/CVP Export Service Areas

Under Alternative 7A LLT, long-term average chloride concentrations for the 16-year period modeled at the Banks and Jones pumping plants would decrease by as much as 65% relative to existing conditions, 41% relative to No Action Alternative NT, and 38% compared to No Action Alternative LLT (Appendix 8G, Chloride Table Cl-29). The modeled frequency of exceedances of applicable water quality objectives/criteria would decrease relative to existing conditions, No Action Alternative NT, and No Action Alternative LLT, for both the 16-year period and the drought period modeled (Appendix 8G, Chloride Table Cl-30). Consequently, water exported into the SWP/CVP service area would generally be of similar or better quality with regards to chloride relative to existing conditions and the No Action Alternative NT and No Action Alternative LLT conditions.

Commensurate with the reduced chloride concentrations in water exported to the service area, reduced chloride loading in the lower San Joaquin River would be anticipated which would likely alleviate or lessen any expected increase in chloride at Vernalis related to decreased annual average San Joaquin River flows (see discussion of Upstream of the Delta).

Maintenance of SWP and CVP facilities would not be expected to create new sources of chloride or contribute towards a substantial change in existing sources of chloride in the affected environment. Maintenance activities would not be expected to cause any substantial change in chloride such that any long-term water quality degradation would occur, thus, beneficial uses would not be adversely affected anywhere in the affected environment.

CEQA Conclusion: Chloride is not a bioaccumulative constituent, thus any increased concentrations under Alternative 7A LLT would not result in adverse chloride bioaccumulation effects on aquatic life or humans. Alternative 7A LLT maintenance would not result in any substantial changes in chloride concentration upstream of the Delta or in the SWP/CVP service area. Relative to existing conditions, Alternative 7A LLT operations would result in reduced chloride concentrations such that exceedances of the 250 mg/L Bay-Delta WQCP objective at the San Joaquin River at Antioch and Mallard Slough would be reduced. However, relative to the existing conditions, the modeled increased chloride concentrations and degradation in the western Delta could still occur and further contribute, at measurable levels (i.e., over a doubling of concentration), to the existing 303(d) listed impairment due to chloride in Suisun Marsh for the protection of fish and wildlife. Also, relative to the existing conditions, long-term degradation at interior Delta locations could still occur and may increase the risk of exceeding aquatic life criteria. Based on these findings, this impact is determined to be potentially significant due to increased chloride concentrations and potential adverse effects on aquatic life beneficial uses in the interior Delta and fish and wildlife beneficial uses in Suisun Marsh.

While implementation of Mitigation Measure WQ-7 may reduce this impact, the feasibility and effectiveness of this mitigation measures is uncertain. Therefore, the available mitigation would not necessarily reduce the impact to a level that would be less than significant.

Mitigation Measure WQ-7: Conduct additional evaluation and modeling of increased chloride levels and develop and implement phased actions to reduce levels

Please see Mitigation Measure WQ-7 under Impact WQ-7 in the discussion of Alternative 1A.

Because Alternative 7A would not result in adverse effects on municipal and industrial water supply beneficial uses in the western Delta, the emphasis and mitigation actions would be limited to those necessary to reduce or avoid adverse effects on Suisun Marsh. Additionally, the mitigation action identified under Alternative 3A would be necessary to reduce or avoid adverse effects on aquatic life at interior Delta locations.

Impact WQ-8: Effects on chloride concentrations resulting from implementation of CM2–CM22

Under Alternative 7A LLT, the types and geographic extent of effects on chloride concentrations in the Delta as a result of implementation of the other conservation measures (i.e., CM2-CM22) would be similar to, and undistinguishable from, those effects previously described for Alternative 1A LLT. The conservation measures would present no new direct sources of chloride to the affected environment. Moreover, some habitat restoration conservation measures (CM4-10) would occur on lands within the Delta currently used for irrigated agriculture, thus replacing agricultural land uses with restored tidal wetlands, floodplain, and related channel margin and off-channel habitats. The potential reduction in irrigated lands within the Delta may result in reduced discharges of agricultural field drainage with elevated chloride concentrations, which would be considered an improvement compared to existing conditions.

CEQA Conclusion: Implementation of the CM2-CM22 for Alternative 7A LLT would not present new or substantially changed sources of chloride to the affected environment upstream of the Delta, within Delta, or in the SWP/CVP service area. Replacement of irrigated agricultural land uses in the Delta with habitat restoration conservation measures may result in some reduction in discharge of agricultural field drainage with elevated chloride concentrations, thus resulting in improved water quality conditions. Based on these findings, this impact is considered to be less than significant. No mitigation is required.

Impact WQ-9: Effects on dissolved oxygen resulting from facilities operations and maintenance (CM1)

Effects of CM1 on dissolved oxygen under Alternative 7 are the same as those discussed for Alternative 1A LLT. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-10: Effects on dissolved oxygen resulting from implementation of CM2– CM22

Effects of CM2–23 on dissolved oxygen under Alternative 7 are the same as those discussed for Alternative 1A LLT. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-11: Effects on electrical conductivity concentrations resulting from facilities operations and maintenance (CM1)

Upstream of the Delta

For the same reasons stated for the No Action Alternative LLT, EC levels (highs, lows, typical conditions) in the Sacramento River and its tributaries, the eastside tributaries, their associated reservoirs, and the San Joaquin River upstream of the Delta under Alternative 7 LLT are not expected to be outside the ranges occurring under existing conditions or would occur under the No Action Alternative NT and LLT. Any minor changes in EC levels that could occur under Alternative 7 LLT in water bodies upstream of the Delta would not be of sufficient magnitude, frequency and geographic extent that would cause adverse effects on beneficial uses or substantially degrade water quality with regard to EC.

Delta

Relative to existing conditions, Alternative 7 LLT would result in an increase in the number of days the Bay-Delta WQCP EC objectives would be exceeded in the San Joaquin River at San Andreas Landing and Prisoners Point, and San Joaquin River at Brandt Bridge (Appendix H, Table EC-7). The percent of days the San Andreas Landing EC objective would be exceeded for the entire period modeled (1976-1991) would increase from 1% under existing conditions to 3% under Alternative 7 LLT, and the percent of days out of compliance with the EC objective would increase from 1% under existing conditions to 6% under Alternative 7 LLT. The percent of days the Prisoners Point EC objective would be exceeded for the entire period modeled would increase from 6% under existing conditions to 35% under Alternative 7 LLT, and the percent of days out of compliance with the EC objective would increase from 10% under existing conditions to 35% under Alternative 7 LLT. In the San Joaquin River at Brandt Bridge, the percent of days exceeding the EC objective would increase from 3% under existing conditions to 4% under Alternative 7 LLT; the percent of days out of compliance would increase from 8% under existing conditions to 9% under Alternative 7 LLT. Average EC levels at the western and southern Delta compliance locations and San Joaquin River at San Andreas Landing (an interior Delta location) would decrease from 0-46% for the entire period modeled and 2-45% during the drought period modeled (1987-1991) (Appendix H, Table EC-18). In the S. Fork Mokelumne River at Terminous, average EC would increase 6% for the entire period modeled and 5% during the drought period modeled. Average EC in the S. Fork Mokelumne River at Terminous would increase during all months (Appendix H, Table EC-18). Average EC in the San Joaquin River at Prisoners Point would increase by 1% during the drought period (Appendix H, Table EC-18).

Relative to the No Action Alternative NT, the change in percent compliance with Bay-Delta WQCP EC objectives under Alternative 7 LLT would be similar to that described above relative to existing conditions. The exception is that there would also be a slight increase (1% or less) in the percent of days the EC objective would be exceeded in the San Joaquin River at Vernalis, and Old River near Middle River for the entire period modeled. For the entire period modeled, average EC levels would increase at all Delta compliance locations relative to the No Action Alternative NT, except in Three Mile Slough near the Sacramento River and the San Joaquin River at Jersey Point. The greatest average EC increase would occur in the San Joaquin River at Prisoners Point (9%); the increase at the other locations would be 3-5% (Appendix H, Table EC-18). Similarly, during the drought period modeled, average EC would increase at all locations, except Three Mile Slough and San Joaquin River at Jersey Point. The greatest average EC increase during the drought period modeled also would occur in the San Joaquin River at Prisoners Point (10%); the increase at the other locations would be 1-5% (Appendix H, Table EC-18).

Relative to the No Action Alternative LLT, the locations with an increased frequency of exceedance of the Bay-Delta WQCP EC objectives under Alternative 7 LLT would differ from that described relative to the No Action Alternative NT (Appendix H, Table EC-7). The percent of days exceeding EC objectives and percent of days out of compliance would increase at: San Joaquin River at Jersey Point, San Andreas Landing, Vernalis, Brandt Bridge, and Prisoners Point; and Old River near Middle River and at Tracy Bridge. The increase in percent of days exceeding the EC objective would be 34% at Prisoners Point and 3% or less at the remaining locations. The increase in percent of days out of compliance would be 34% at Prisoners Point and 5% or less at the remaining locations. Average EC would increase similar to that described above relative to the No Action Alternative NT.

For Suisun Marsh, October-May is the period when Bay-Delta WQCP EC objectives for protection of fish and wildlife apply. Long-term average EC would increase under Alternative 7 LLT, relative to existing conditions, during the months of April and May by 0.2 mS/cm in the Sacramento River at Collinsville (Appendix H, Table EC-21). Long-term average EC would decrease relative to existing conditions in Montezuma Slough at National Steel during October-May (Appendix H, Table EC-22). The most substantial increase would occur near Beldon Landing, with long-term average EC levels increasing by 0.8-3.3 mS/cm, depending on the month, nearly doubling during some months the long-term average EC relative to existing conditions (Appendix H, Table EC-23). Sunrise Duck Club and Volanti Slough also would have long-term average EC increases of 0.1-1.6 mS/cm (Appendix H, Tables EC-24 and EC-25). The degree to which the long-term average EC increases would cause exceedance of Bay-Delta WQCP objectives is unknown, because objectives are expressed as a monthly average of daily high tide EC, which does not have to be met if it can be demonstrated "equivalent or better protection will be provided at the location" (State Water Resources Control Board 2006:14). The described long-term average EC increase may, or may not, contribute to adverse effects on beneficial uses, depending on how and when wetlands are flooded, soil leaching cycles, and how recirculation of water is managed, and future actions taken with respect to the marsh. However, the EC increases at certain locations would be substantial and it is uncertain the degree to which current management plans for the Suisun Marsh would be able to address these substantially higher EC levels and protect beneficial uses. Thus, these increased EC levels in Suisun Marsh are considered to have a potentially adverse effect on marsh beneficial uses. Long-term average EC increases in Suisun Marsh under Alternative 7 LLT relative to the No Action Alternative NT and LLT would be similar to the increases relative to existing conditions.

Given that the southern Delta is Clean Water Act section 303(d) listed as impaired due to elevated EC, the increase in the incidence of exceedance of EC objectives under Alternative 7 LLT, relative to existing conditions and the No Action Alternative NT and LLT, has the potential to contribute to additional impairment and potentially adversely affect beneficial uses. Suisun Marsh also is section 303(d) listed as impaired due to elevated EC, and the potential increases in long-term average EC concentrations could contribute to additional impairment, because the increases would be double that relative to existing conditions and the No Action Alternative NT and LLT.

SWP/CVP Export Service Areas

At the Banks and Jones pumping plants, Alternative 7 LLT would result in no exceedances of the Bay-Delta WQCP's 1,000 μmhos/cm EC objective for the entire period modeled (Appendix H, Table

EC-10). Thus, there would be no adverse effect to the beneficial uses in the SWP/CVP Export Service Areas using water pumped at this location under the Alternative 7 LLT.

At the Banks pumping plant, relative to existing conditions, average EC levels under Alternative 7 LLT would decrease substantially: 47% for the entire period modeled and 51% during the drought period modeled. Relative to the No Action Alternative NT, average EC levels would decrease by 43% for the entire period modeled and 47% during the drought period modeled. Similar decreases in average EC would occur relative to the No Action Alternative LLT. (Appendix H, Table EC-18)

At the Jones pumping plant, relative to existing conditions, average EC levels under Alternative 7 LLT would also decrease substantially: 52% for the entire period modeled and 59% during the drought period modeled. Relative to the No Action Alternative NT, average EC levels would decrease by 49% for the entire period modeled and 57% during the drought period modeled. Similar decreases in average EC would occur relative to the No Action Alternative LLT. (Appendix H, Table EC-18)

Based on the decreases in long-term average EC levels that would occur at the Banks and Jones pumping plants, Alternative 7 LLT would not cause degradation of water quality with respect to EC in the SWP/CVP Export Service Areas; rather, Alternative 7 LLT would improve long-term average EC conditions in the SWP/CVP Export Service Areas.

Commensurate with the EC decrease in exported waters, an improvement in lower San Joaquin River average EC levels would be expected since EC in the lower San Joaquin River is, in part, related to irrigation water deliveries from the Delta. While the magnitude of this expected lower San Joaquin River improvement in EC is difficult to predict, the relative decrease in overall loading of EC-elevating constituents to the Export Service Areas would likely alleviate or lessen any expected increase in EC at Vernalis related to decreased annual average San Joaquin River flows (see EC impact discussion under No Action Alternative LLT).

The export area of the Delta is listed on the state's CWA Section 303(d) list as impaired due to elevated EC. Alternative 7 LLT would result in lower average EC levels relative to existing conditions and the No Action Alternative NT and LLT and, thus, would not contribute to additional beneficial use impairment related to elevated EC in the SWP/CVP Export Service Areas waters.

CEQA Conclusion: Relative to existing conditions, Alternative 7 LLT would not result in any substantial increases in long-term average EC levels upstream of the Delta or in the SWP/CVP Export Service Areas. In the Delta region, Alternative 7 LLT would result in an increase in the frequency with which Bay-Delta WQCP EC objectives are exceeded in the San Joaquin River at San Andreas Landing (agricultural objective; 2% increase) and Brandt Bridge (agricultural objective; 1% increase) in the southern Delta, and Prisoners Point (fish and wildlife objective; 29% increase) in the interior Delta for the entire period modeled (1976-1991). The increased frequency of exceedance of the fish and wildlife objective at Prisoners Point could contribute to adverse effects on aquatic life. Because EC is not bioaccumulative, the increases in long-term average EC levels would not directly cause bioaccumulative problems in aquatic life or humans. The southern Delta is Clean Water Act section 303(d) listed for elevated EC and the increased frequency of exceedance of EC objectives that would occur in this region of the Delta could make beneficial use impairment measurably worse. This impact is considered to be potentially significant.

Further, relative to existing conditions, Alternative 7 LLT would result in substantial increases in long-term average EC during the months of October through May in Suisun Marsh, such that EC levels would be double that relative to existing conditions. The increases in long-term average EC levels that would occur in Suisun Marsh could further degrade existing EC levels and thus contribute additionally to adverse effects on the fish and wildlife beneficial uses. Because EC is not bioaccumulative, the increases in long-term average EC levels would not directly cause bioaccumulative problems in wildlife. Suisun Marsh is Clean Water Act section 303(d) listed for elevated EC and the increases in long-term average EC that would occur in the marsh could make beneficial use impairment measurably worse. This impact is considered to be potentially significant.

While Mitigation Measure WQ-11 (see Alternative 1A) may reduce these impacts, the feasibility and effectiveness of this mitigation measures is uncertain. Therefore, the available mitigation would not necessarily reduce the impact to a level that would be less than significant.

Mitigation Measure WQ-11: Reduce, avoid, and compensate for reduced water quality conditions

Please see Mitigation Measure WQ-11 under Impact WQ-11 in the discussion of Alternative 1A.

Impact WQ-12: Effects on electrical conductivity resulting from implementation of CM2–CM22

Effects of CM2–CM22 on EC under Alternative 7 LLT are the same as those discussed for Alternative 1A LLT. There would be no adverse effect. Under CEQA, this impact would be considered less than significant. No mitigation is required.

Impact WQ-13: Effects on mercury concentrations resulting from facilities operations and maintenance (CM1)

[*Note to Lead Agencies: This assessment is in preparation*].

Impact WQ-14: Effects on mercury concentrations resulting from implementation of CM2–CM22

[*Note to Lead Agencies: This assessment is in preparation*].

Impact WQ-15: Effects on nitrate concentrations resulting from facilities operations and maintenance (CM1)

Upstream of the Delta

For the same reasons stated for the No Action Alternative LLT, Alternative 7 LLT would have negligible, if any, impact on nitrate concentrations in the rivers and reservoirs upstream of the Delta in the Sacramento River watershed relative to existing conditions and the No Action Alternative NT and LLT.

Under Alternative 7 LLT, modeling indicates that long-term annual average flows on the San Joaquin River would decrease by an estimated 6%, relative to existing conditions, 5% relative to No Action NT, and would remain virtually the same relative to No Action LLT (crossreference to Modeling Data Appendix, CALSIM Flow Data for Vernalis). Given these relatively small decreases in flows and the weak correlation between nitrate and flows in the San Joaquin River (see Nitrate Appendix J Figure 2), it is expected that nitrate concentrations in the San Joaquin River will be minimally affected, if at all, by changes in flow rates under Alternative 7 LLT.

Any negligible changes in nitrate-N concentrations that may occur in the water bodies of the affected environment located upstream of the Delta would not be of frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the quality of these water bodies, with regards to nitrate.

Delta

Results of the mixing calculations indicate that under Alternative 7 LLT, relative to existing conditions, No Action NT, and No Action LLT, nitrate concentrations throughout the Delta are anticipated to remain low (<1.4 mg/L-N) relative to adopted objectives (Nitrate Appendix J Table 25 and 26). Long-term average nitrate concentrations are anticipated to increase at most locations in the Delta. The increase would be greatest at Franks Tract, Old River at Rock Slough, and Contra Costa Pumping Plant #1 (all >85% increase). Long-term average concentrations were estimated to increase to 0.67, 1.04 and 1.10 mg/L-N for Franks Tract, Old River at Rock Slough, and Contra Costa Pumping Plant#1, respectively, due primarily to increased San Joaquin River water percentage at these locations (see Fingerprinting Appendix D). Although changes at specific Delta locations and for specific months may be substantial on a relative basis, the absolute concentration of nitrate in Delta waters would remain low (<1.4 mg/L-N) in relation to the drinking water MCL of 10 mg/L-N, as well as all other thresholds identified in Table XX. No additional exceedances of the MCL are anticipated at any location (Nitrate Appendix J Table 25). On a monthly average basis and on a long term annual average basis, for all modeled years and for the drought period (1987-1991) only, use of assimilative capacity available under existing conditions, No Action NT, and No Action LLT, relative to the drinking water MCL of 10 mg/L-N, was up to approximately 13% at Old River at Rock Slough and Contra Costa Pumping Plant #1, and averaged approximately 6% on a long-term average basis(Nitrate Appendix J Table 27). Similarly, the use of available assimilative capacity at Franks Tract was up to approximately 6%, and averaged 3% over the long term. The concentrations estimated for these locations would not increase the likelihood of exceeding the 10 mg/L-N MCL, nor would they increase the risk for adverse effects to beneficial uses. At all other locations, use of assimilative capacity was negligible (<5%) (Nitrate Appendix J Table 27).

Nitrate concentrations will likely be higher than the modeling results indicate in certain locations, including: (1) in the Sacramento River between Freeport and Mallard Island and other areas in the Delta downstream of Freeport that are influenced by Sacramento River water, the increase becoming greater with increasing distance downstream, due to conversion of ammonia from the SRWTP discharge at Freeport (under existing conditions and No Action Alternative NT only, since upgrades to SRWTP that substantially reduce ammonia concentrations in the Sacramento River downstream of Freeport are assumed in the LLT; see the Ammonia section of this chapter for further discussion); (2) immediately downstream of wastewater treatment plants that practice nitrification, but not denitrification (e.g., City of Rio Vista Beach WWTF, Town of Discovery Bay WWTF, City of Stockton RWCF).

The effect of (1) (above) is expected to be small, on the order of 1 mg/L nitrate as N or less in the existing conditions and No Action Alternative NT. This is because the existing increase appears to be from approximately 0.1 mg/L-N to approximately 0.4-0.5 mg/L-N over this reach, due to approximately a 1:1 conversion of ammonia-N to nitrate-N (CVWQCB 2010:32). Because this nitrate is assumed not to be generated under Alternative 7 LLT, average concentrations would be expected to decrease under Alternative 7 LLT in this reach of the Sacramento River relative to existing conditions and the No Action Alternative NT. Regarding number (2) (above), for all such facilities in the Delta, the Regional Water Boards have issued NPDES permits that allow discharge of wastewater containing nitrate into the Delta, and under these permits, the State has determined that no beneficial uses are adversely affected by the discharge, and that the discharger's use of available assimilative capacity of the water body is acceptable. When dilution is necessary in order for the discharge to be in compliance with the Basin Plans (which incorporate the 10 mg/L-N MCL by reference), not all of the assimilative capacity of the receiving water is granted to the discharger. Thus, limited decreases in flows are not anticipated to result in systemic exceedances of the MCLs by these POTWs. Furthermore, NPDES permits are renewed on a 5-year basis, and thus, if under changes in flows, dilution was no longer sufficient to maintain nitrate below the MCL in the receiving water, the NPDES permit renewal process would address such cases.

Therefore, any increases in nitrate-N concentrations that may occur at certain locations within the Delta would not be of frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the water quality at these locations, with regards to nitrate.

SWP/CVP Export Service Areas

Assessment of effects of nitrate in the SWP and CVP Export Service Areas is based on effects on nitrate-N at the Banks and Jones pumping plants.

Results of the mixing calculations indicate that under Alternative 7 LLT, relative to existing conditions, No Action NT, and No Action LLT, nitrate concentrations at Banks and Jones pumping plants are anticipated to decrease on a long-term average annual basis (Nitrate Appendix J Table 25 and 26). During the late summer, particularly in the drought period assessed, concentrations are expected to increase substantially on a relative basis (i.e., >50%), but the absolute value of these changes (i.e., in mg/L-N) is small. Additionally, given the many factors that contribute to potential algal blooms in the SWP and CVP canals within the Export Service Area, and the lack of studies that have shown a direct relationship between nutrient concentrations in the canals and reservoirs and problematic algal blooms in these water bodies, there is no basis to conclude that these small (i.e., generally <0.3 mg/L-N), seasonal increases in nitrate concentrations would increase the potential for problem algal blooms in the SWP and CVP Export Service Area. No additional exceedances of the MCL are anticipated (Nitrate Appendix J Table 25). On a monthly average basis and on a long term annual average basis, for all modeled years and for the drought period (1987-1991) only, use of assimilative capacity available under existing conditions and No Action NT, relative to the 10 mg/L-N MCL, was negligible for both Banks and Jones pumping plants (Nitrate Appendix J Table 27).

Any increases in nitrate-N concentrations that may occur in water exported via Banks and Jones pumping plants are not expected to result in an adverse effects to beneficial uses or substantially degrade the quality of exported water, with regards to nitrate.

CEQA Conclusion: This alternative is not expected to cause additional exceedance of applicable water quality objectives/criteria by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. No long-term water quality degradation is expected to occur such that exceedance of criteria is more likely or such that there is an increased risk of adverse impacts to beneficial uses. Nitrate is not 303(d) listed within the affected environment and thus any increases than may occur in some areas and months would not make any existing nitrate-related impairment measurably worse because no such impairments currently exist. Because nitrate is not bioaccumulative, increases that may occur in some areas and months would not bioaccumulate to greater levels in aquatic organisms that would, in turn, pose substantial health risks to fish, wildlife, or humans. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-16: Effects on nitrate concentrations resulting from implementation of CM2–23

Effects of CM2–23 on nitrate under Alternative 7 LLT are the same as those discussed for Alternative 1A LLT. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-17: Effects on dissolved organic carbon concentrations resulting from facilities operations and maintenance (CM1)

Upstream of the Delta

Under Alternative 7 LLT, there would be no substantial change to the sources of DOC within the watersheds upstream of the Delta. Moreover, long-term average flow and DOC levels in the Sacramento River at Hood and San Joaquin River at Vernalis are poorly correlated. Thuschanges in system operations and resulting reservoir storage levels and river flows would not be expected to cause a substantial long-term change in DOC concentrations in the water bodies upstream of the Delta. Any negligible changes in DOC levels in water bodies upstream of the Delta under Alternative 7 LLT, relative to existing conditions and the No Action Alternative NT and LLT, would not be of sufficient frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the quality of these water bodies, with regards to DOC.

Delta

Under Alternative 7 LLT, the geographic extent of effects pertaining to long-term average DOC concentrations in the Delta would be similar to that previously described for Alternative 1A LLT, although the magnitude of predicted long-term increase and relative frequency of concentration threshold exceedances would be substantially greater. Modeled effects would be greatest at Franks Tract, Rock Slough, and Contra Costa PP No. 1., where for the 16-year hydrologic period and the modeled drought period, long-term average concentration increases ranging from 0.7-1.1 mg/L would be predicted (≤30% net increase), resulting in long-term average DOC concentrations greater than 4 mg/L at Rock Slough and Contra Costa PP No. 1 (Appendix 8K, DOC Table 8). Increases in long-term average concentrations would correspond to more frequent concentration threshold exceedances, with the greatest change occurring at Rock Slough and Contra Costa PP No. 1 locations. For Rock Slough, long-term average DOC concentrations exceeding 3 mg/L would increase from 52% under existing conditions to 85% under the Alternative 7 LLT (an increase from 47% to 82% for the drought period), and concentrations exceeding 4 mg/L would increase from 30% to 47% (32% to 57% for the drought period). For Contra Costa PP No. 1, long-term average DOC concentrations exceeding 3 mg/L would increase from 52% under existing conditions to 85% under Alternative 7 LLT (45% to 88% for the drought period), and concentrations exceeding 4 mg/L would increase from 32% to 52% (35% to 58% for the drought period). Relative change in frequency of threshold exceedance for other assessment locations would be similar or less.

In comparison, Alternative 7 LLT relative to the No Action Alternative NT and No Action Alternative LLT would generally result in a similar magnitude of change to that discussed for the comparison to existing conditions. Maximum increases of 0.7-1.1 mg/L DOC (i.e., ≤31%) would be predicted at Franks Tract, Rock Slough, and Contra Costa PP No. 1 relative to No Action Alternative NT, while maximum increases at these locations would be slightly less (i.e., between 0.7-0.9 mg/L, ≤26%) when compared to No Action Alternative LLT (Appendix 8K, DOC Table 8). Threshold concentration exceedance frequency trends would also be similar to that discussed for the existing condition comparison, with exception to the predicted 4 mg/L exceedance frequency at Buckley Cove. In comparison to the No Action Alternative NT, the frequency which long-term average DOC concentrations exceeded 4 mg/L at Buckley Cove would increase from 23% to 33% (37% to 57% for the modeled drought period), with slightly smaller increases when comparing to No Action Alternative LLT.

The increases in long-term average DOC concentrations estimated to occur at Franks Tract, Rock Slough, and Contra Costa PP No. 1 are considered substantial and could potentially trigger significant changes in drinking water treatment plant design or operations. In particular, assessment locations at Rock Slough and Contra Costa PP No. 1 represent municipal intakes servicing existing drinking water treatment plants. Under Alternative 7, drinking water treatment plants obtaining water from these interior Delta locations would likely need to upgrade existing treatment systems in order to achieve EPA Stage 1 Disinfectants and Disinfection Byproduct Rule action thresholds. While treatment technologies sufficient to achieve the necessary DOC removals exist, implementation of such technologies would likely require substantial investment in new or modified infrastructure.

Relative to existing, No Action Alternative NT, and No Action Alternative LLT conditions, Alternative 7 LLT would lead to predicted improvements in long-term average DOC concentrations at Barker Slough, Banks and Jones pumping plants. Predicted long-term average DOC concentrations at Barker Slough would decrease 0.1-0.2 mg/L, while long-term average DOC concentrations at Banks and Jones would decrease as much as 1.0-1.3 mg/L, depending on baseline conditions comparison and modeling period.

SWP/CVP Export Service Areas

Under Alternative 7 LLT, modeled long-term average DOC concentrations would decrease at Banks and Jones pumping plants for both the modeled 16-year hydrologic period and the modeled drought period. Modeled decreases would generally be similar between existing conditions, No Action Alternative NT, and No Action Alternative LLT. Relative to existing conditions, long-term average DOC concentrations at Banks would be predicted to decrease by 1.1 mg/L (1.3 mg/L during drought period) (Appendix 8K, DOC Table 8). At Jones, long-term average DOC concentrations would be predicted to decrease by 1.0 mg/L (1.2 mg/L during drought period). Such substantial improvement in long-term average DOC concentrations would include fewer exceedances of concentration thresholds. Average DOC concentrations exceeding the 2 mg/L concentration threshold would decrease from 100% under existing conditions, No Action Alternative NT and No Action Alternative LLT to 67% at Banks and 61% at Jones under Alternative 7 (60% and 57%, respectively during the drought period), while concentrations exceeding 4 mg/L would nearly be eliminated (i.e., ≤15% exceedance frequency). Such modeled improvement would correspond to substantial improvement in Export Service Areas water quality, respective to DOC.

Similar to the discussion pertaining to the No Action Alternative LLT, maintenance of SWP and CVP facilities under Alternative 7 LLT would not be expected to create new sources of DOC or contribute towards a substantial change in existing sources of DOC in the affected area. Maintenance activities would not be expected to cause any substantial change in long-term average DOC concentrations such that MUN beneficial uses, or any other beneficial use, would be adversely affected.

***CEQA Conclusion*:** Relative to existing conditions, Alternative 7 LLT operation and maintenance would not result in any substantial change in long-term average DOC concentration upstream of the Delta. Furthermore, under Alternative 7 LLT, water exported from the Delta to the SWP/CVP service area would be substantially improved relative to DOC. DOC is not bioaccumulative, therefore change in long-term average DOC concentrations would not directly cause bioaccumulative problems in aquatic life or humans. Additionally, DOC is not a constituent related to any 303(d) listings.

Nevertheless, new and modified conveyance facilities proposed under Alternative 7 LLT would result in a substantial increase in long-term average DOC concentrations (i.e., 0.7-1.1 mg/L, equivalent to ≤30% relative increase) at Franks Tract, Rock Slough, and Contra Costa PP No.1. In particular, under Alternative 7 LLT, model predicted long-term average DOC concentrations would be greater than 4 mg/L at Rock Slough and Contra Costa PP No. 1 with commensurate substantial increases in the frequency with which average DOC concentrations exceed 2, 3, and 4 mg/L levels. Drinking water treatment plants obtaining water from these interior Delta locations would likely need to upgrade existing treatment systems in order to achieve EPA Stage 1 Disinfectants and Disinfection Byproduct Rule action thresholds. Therefore, such a magnitude change in long-term average DOC concentrations would represent a substantially increased risk for adverse effects on existing MUN beneficial uses at Rock Slough and Contra Costa PP No. 1 should such treatment upgrades not be undertaken. The impact is considered significant and mitigation is required. While Mitigation Measure WQ-17 is available to partially reduce this impact of DOC, the feasibility and effectiveness of this mitigation measures is uncertain and therefore it is not known if its implementation would reduce the identified impact to a level that would be less than significant.

Mitigation Measure WQ-17:

To reduce the effect of CM1 operations on increased DOC concentrations specifically predicted to occur at municipal water purveyors obtaining raw source water through south Delta intakes at Rock Slough and those associated with Contra Costa PP No. 1, DWR and Reclamation shall coordinate with the purveyors to identify the means to compensate for increases in long-term average DOC concentrations. DWR and Reclamation shall implement any combination of measures sufficient to maintaining DBP concentrations at existing levels (i.e., as system-wide running annual average) in treated drinking water of affected water purveyors. Such actions may include, but not be limited to, providing monetary compensation sufficient to: 1) upgrade and maintain adequate drinking water treatment systems, 2) develop or obtain replacement surface water supplies from other water rights holders, 3) develop replacement groundwater supplies, or 4) physically route a portion of the water diverted from the Sacramento River through the associated new conveyance pipelines/tunnel to affected purveyors.

Impact WQ-18: Effects on dissolved organic carbon concentrations resulting from implementation of CM2– CM22

Conservation components under Alternative 7 would be similar to those under Alternative 1A, but 40 linear miles rather than 20 linear miles of channel margin habitat would be enhanced, and 20,000 acres rather than 10,000 acres of seasonally inundated floodplain would be restored. Effects on DOC resulting from the implementation of CM2-CM22 would be similar to that previously discussed for Alternative 1A LLT, except that the increased linear miles of channel margin habitat enhancement and increased acreage of seasonally inundated floodplain would increase the overall Alternative 7 DOC loading to the Delta. In total, conservation measures CM4-CM7 and CM10 could contribute substantial amounts of DOC to raw drinking water supplies, largely depending on final design and operational criteria for the related restoration activities. Substantially increased long-term average DOC in raw water supplies could lead to a need for treatment plant upgrades in order to appropriately manage DBP formation in treated drinking water. This potential for future DOC increases would lead to substantially greater associated risk of long-term adverse effects on the MUN beneficial use.

CEQA Conclusion: Effects of CM4-CM7 and CM10 on DOC under Alternative 7 LLT are similar to, and possibly greater than, those discussed for Alternative 1A LLT. Similar to the discussion for Alternative 1A, this impact is considered to be significant. It is uncertain whether implementation of Mitigation Measure WQ-18 would reduce identified impacts to a less than significant level. Hence, this impact could remain significant after mitigation.

Mitigation Measure WQ-18: Design wetland and riparian habitat features to minimize effects on municipal intakes

Please see Mitigation Measure WQ-18 under Impact WQ-18 in the discussion of Alternative 1A.

Impact WQ-19: Effects on pathogens resulting from facilities operations and maintenance

Effects of CM1 on pathogens under Alternative 7 are the same as those discussed for Alternative 1A LLT. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-20: Effects on pathogens resulting from implementation of CM2–CM22

Effects of CM2–CM22on pathogens under Alternative 7 are the same as those discussed for Alternative 1A LLT. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-21: Effects on pesticide concentrations resulting from facilities operations and maintenance (CM1)

Upstream of the Delta

For the same reasons stated for the No Action Alternative LLT, under Alternative 7 LLT no specific operations or maintenance activity of the SWP or CVP would substantially drive a change in pesticide use, and thus pesticide sources would remain unaffected upstream of the Delta. Nevertheless, changes in the timing and magnitude of reservoir releases could have an effect on available dilution capacity along river segments such as the Sacramento, Feather, American, and San Joaquin Rivers.

Under Alternative 7 LLT, winter (November –March) and summer (April – October) season average flow rates on the Sacramento River at Freeport, American River at Nimbus, Feather River at Thermalito and the San Joaquin River at Vernalis would change. Relative to existing condition, No Action Alternative NT and No Action Alternative LLT, seasonal average flow rates on the Sacramento would decrease no more than 5% during the summer and 4% during the winter relative to existing conditions (Appendix 8L, Seasonal average flows Tables 1-4). On the Feather River, average flow rates would decrease no more than 5% during the summer, but would increase as much as 14% in the winter. American River average flow rates would decrease by as much as 15% in the summer but would increase by as much as 9% in the winter. Seasonal average flow rates on the San Joaquin River would decrease by as much as 12% in the summer, but increase by as much as 3% in the winter. For the same reasons stated for the No Action Alternative LLT, decreased seasonal average flow of ≤15% is not considered to be of sufficient magnitude to substantially increase pesticide concentrations or alter the long-term risk of pesticide-related toxicity to aquatic life, nor adversely affect other beneficial uses of water bodies upstream of the Delta.

Delta

Sources of diuron, OP and pyrethroid insecticides to the Plan Area include direct input of surface runoff from in-Delta agriculture and Delta urbanized areas as well inputs from rivers upstream of the Delta. Similar to Upstream of the Delta, CVP/SWP operations would not affect these sources.

Under Alternative 7 LLT, the distribution and mixing of Delta source waters would change. Percent change in monthly average source water fraction were evaluated for the modeled 16-year (1976-1991) hydrologic period and a representative drought period (1987-1991), with special attention given to changes in San Joaquin River, Sacramento River and Delta Agriculture sources water fractions. Relative to existing conditions, under Alternative 7 LLT modeled San Joaquin River fractions would increase greater than 10% at Franks Tract, Rock Slough, Contra Costa PP No. 1, and the San Joaquin River at Antioch (Appendix 8D, Source Water Fingerprinting). At Antioch, San Joaquin River source water fractions when modeled for the 16-year hydrologic period would increase by 11-14% from November through May (no increase >10% for the modeled drought period). While this change at Antioch is not considered substantial, changes in San Joaquin River source water fraction in the Delta interior would be considerable. At Franks Tract, San Joaquin River source water fractions would increase between 18-28% for October through June (12-25% for November through June of the modeled drought period). Changes at Rock Slough and Contra Costa PP No. 1 would be very similar, where modeled San Joaquin River source water fractions would increase from 27-71% (11-70% for the modeled drought period) for October through June. Relative to existing conditions, there would be no modeled increases in Sacramento River fractions greater than 16% (with exception to Banks and Jones which are discussed below) and Delta agricultural fractions greater than 6%. Increases in San Joaquin River source water fraction at Franks Tract, Rock Slough, and Contra Costa PP NO. 1 would primarily balance through decreases in Sacramento River water, and as a result the San Joaquin River would account for greater than 50% of the total source water volume at Franks Tract between March through May (<50% for all months during the modeled drought period), and would be 50%, and as much as 81% during November through May at Rock Slough and Contra Costa PP No. 1 for both the modeled drought and 16-year hydrologic periods. While the source water and potential pesticide related toxicity co-occurrence predictions do not mean adverse effect would occur, such considerable modeled increases in early summer source water fraction at Franks Tract and winter and summer source water fractions at Rock Slough and Contra Costa PP No. 1 could substantially alter the long-term risk of pesticide-related toxicity to aquatic life, given the apparent greater incidence of pesticides in the San Joaquin River.

When compared to No Action Alternative NT and No Action Alternative LLT, changes in source water fractions would be similar in season, geographic extent, and magnitude to those discussed for existing conditions with exception to Buckley Cove during the modeled drought period. At Buckley Cove, modeled drought period San Joaquin River fractions would increase 15% in July and 14% in August when compared to No Action Alternative LLT (Appendix 8D, Source Water Fingerprinting). These increases would primarily balance through decreases in Sacramento River water and eastside tributary waters. Nevertheless, the San Joaquin River at Buckley Cove during the modeled drought period would only account for 36% of the total source water volume in July and 26% in August. These changes at Buckley Cove are not considered substantial, however, as discussed for existing conditions, under No Action Alternative NT and No Action Alternative LLT the similar magnitude change at Franks Tract, Rock Slough, and Contra Costa PP No. 1 would be considered substantial and could substantially the long-term risk of pesticide-related toxicity to aquatic life.

These predicted adverse effects on pesticides relative to existing conditions, No Action Alternative NT, and No Action Alternative LLT fundamentally assume that the present pattern of pesticide incidence in surface water will occur at similar levels into the future. In reality, however, the makeup and character of the pesticide use market in the late long-term (i.e., the year 2060) will not be exactly as it istoday. Current use of chlorpyrifos and diazinon is on the decline with their replacement by pyrethroids on the rise, yet in this assessment it is the apparent greater incidence of diazinon and chlorpyrifos on the San Joaquin River that serves as the basis for concluding that substantially increased San Joaquin River source water fraction would correspond to an increased risk of pesticide-related toxicity to aquatic life. By 2060, however, alternatives pesticides, such as neonicitinoids and biologicals, will likely be a more substantial contributing part of the existing mix of pesticides, and perhaps more prominent. The trend in the development of future-use pesticides is towards reduced risk pesticides, including more biopesticides, with greater targeted specificity, fewer residues, and lower overall non-target toxicity. By 2060 existing chlorpyrifos and diazinon TMDLs for the Sacramento and San Joaquin Rivers will have been in effect for more than 50 years. Moreover, it is reasonable to expect that CWA section 303(d) listings and future additional listings will have developed TMDLs by 2060. To the extent these existing and future TMDL's address current and future-use pesticides, a greater degree of pesticide related source control can be anticipated. Nevertheless, forecasting whether these various efforts will ultimately be successful at resolving current pesticide related impairments requires considerable speculation. While the fundamental assumptions that have guided this assessment of pesticides may be somewhat altered by 2060, these assumptions are informed by actual studies and monitoring data collected from the recent past and, therefore, judging project alternative effects in the future remain most accurate through use of these informed assumptions rather than based on assumptions founded upon future speculative conditions.

SWP/CVP Export Service Areas

Assessment of effects in SWP/CVP Export Service Areas is based on effects seen in the Plan Area at the Banks and Jones pumping plants. Under Alternative 7 LLT, Sacramento River source water fractions would increase substantially at both Banks and Jones pumping plants relative to existing conditions, No Action Alternative NT and No Action Alternative LLT (Appendix 8D, Source Water Fingerprinting). At Banks pumping plant, Sacramento source water fractions would generally increase from 27-79% for October through June (13-32% for December through March of the modeled drought period) and at Jones pumping plant Sacramento source water fractions would generally increase from 43-96% for October through June (37-89% for October through June of the modeled drought period). These increases in Sacramento source water fraction would primarily balance through equivalent decreases in San Joaquin River water. Based on the general observation that San Joaquin River, in comparison to the Sacramento River, is a greater contributor of OP insecticides in terms of greater frequency of incidence and presence at concentrations exceeding water quality benchmarks, modeled increases in Sacramento River fraction at Banks and Jones would generally represent an improvement in export water quality respective to pesticides.

***CEQA Conclusion*:** Relative to existing conditions, the Alternative 7 LLT would not result in any substantial change in long-term average pesticide concentration or result in substantial increase in the anticipated frequency with which long-term average pesticide concentrations would exceed aquatic life toxicity thresholds or other beneficial use effect thresholds upstream of the Delta or the SWP/CVP service area. Numerous pesticides are currently used throughout the affected environment, and while some of these pesticides may be bioaccumulative, those present-use pesticides for which there is sufficient evidence for their presence in waters affected by SWP and

CVP operations (i.e., diazinon, chlorpyrifos, diuron, and pyrethroids) are not considered bioaccumulative, and thus changes in their concentrations would not directly cause bioaccumulative problems in aquatic life or humans. Furthermore, while there are numerous 303(d) listings throughout the affected environment that name pesticides as the cause for beneficial use impairment, the modeled changes in upstream river flows and Delta source water fractions would not be expected to make any of these beneficial use impairments measurably worse, with principal exception to locations in the Delta that would receive a substantially greater fraction San Joaquin River water under Alternative 7. Long-term average San Joaquin River source water fractions at Franks Tract, Rock Slough and Contra Costa PP No. 1 locations would change considerably for some months such that the long-term risk of pesticide-related toxicity to aquatic life could substantially increase. Additionally, the potential for increased incidence of pesticide related toxicity could include pesticides such as chlorpyrifos and diazinon for which existing 303(d) listings exist for the Delta, and thus existing beneficial use impairment could be made discernibly worse. The impact is considered to be significant and unavoidable. There is no feasible mitigation available to reduce the effect of this significant impact.

Impact WQ-22: Effects on pesticide concentrations resulting from implementation of CM2–CM22

Conservation components under Alternative 7 would be similar to those under Alternative 1A, but 40 linear miles rather than 20 linear miles of channel margin habitat would be enhanced, and 20,000 acres rather than 10,000 acres of seasonally inundated floodplain would be restored. Effects on pesticides resulting from the implementation of CM2–CM22would be similar to that previously discussed for Alternative 1A LLT. In summary, CM13 proposes the use of herbicides to control invasive aquatic vegetation around habitat restoration sites. Herbicides directly applied to water could include adverse effects on non-target aquatic life, such as aquatic invertebrates and beneficial aquatic plants. As such, aquatic life toxicity objectives could be exceeded with sufficient frequency and magnitude such that beneficial uses would be impacted.

CEQA Conclusion: Effects of CM2–CM22on pesticides under Alternative 7 LLT are the similar as those discussed for Alternative 1A LLT. Potential environmental effects related only to CM13 are considered to be significant. Mitigation is required. While Mitigation Measure WQ-22 is available to partially reduce this impact of pesticides, no feasible mitigation is available that would reduce it to a level that would be less than significant.

Mitigation Measure WQ-22: Implement least toxic integrated pest management strategies

Please see Mitigation Measure WQ-22 under Impact WQ-22 in the discussion of Alternative 1A.

Impact WQ-23: Effects on phosphorus concentrations resulting from facilities operations and maintenance (CM1)

Effects of water facilities and operations (CM1) on phosphorus levels in water bodies of the affected environment under Alternative 3 LLT would be very similar (i.e., nearly the same) as those discussed for Alternative 1A LLT. Consequently, the environmental consequences to phosphorus levels discussed in detail for Alternative 1A LLT also adequately represent the effects under Alternative 3 LLT. Based on this finding, this impact is considered to be less than significant. No mitigation is required.

Impact WQ-24: Effects on phosphorus concentrations resulting from implementation of CM2–CM22

Effects of CM2–23 on phosphorus levels in water bodies of the affected environment under Alternative 7 LLT would be very similar (i.e., nearly the same) as those discussed for Alternative 1A LLT. Consequently, the environmental consequences to phosphorus levels from implementing CM2-CM22 discussed in detail for Alternative 1A LLT also adequately represent the effects of these same actions under Alternative 7 LLT. Based on this finding, this impact is considered to be less than significant. No mitigation is required.

Impact WQ-25: Effects on selenium concentrations resulting from facilities operations and maintenance (CM1)

[*Note to Lead Agencies: This assessment is in preparation*].

Impact WQ-26: Effects on selenium concentrations resulting from implementation of CM2–CM22

[*Note to Lead Agencies: This assessment is in preparation*].

Impact WQ-27: Effects on trace metal concentrations resulting from facilities operations and maintenance (CM1)

Upstream of the Delta

For the same reasons stated for the No Action Alternative LLT, Alternative 7 LLT would result in negligible, and likely immeasurable, increases in trace metal concentrations in the rivers and reservoirs upstream of the Delta, relative to existing conditions, No Action NT and No Action LLT. Effects due to the operation and maintenance of the conveyance facilities are expected to be immeasurable, on an annual and long-term average basis. As such, the Alternative 7 would not be expected to substantially increase the frequency with which applicable Basin Plan objectives or CTR criteria would be exceeded in water bodies of the affected environment located upstream of the Delta or substantially degrade the quality of these water bodies, with regard to trace metals.

Delta

For the same reasons stated for the No Action Alternative LLT, Alternative 7 LLT would not result in substantial increases in trace metal concentrations in the Delta relative to existing conditions, No Action NT, and No Action LLT. However, substantial changes in source water fraction would occur in the south Delta (see Appendix D [editor: reference to Fingerprinting Appendix]). Throughout much of the south Delta, San Joaquin River water would replace Sacramento River water, with the future trace metals profile largely reflecting that of the San Joaquin River. As discussed for the No Action Alternative, trace metal concentration profiles between the San Joaquin and Sacramento Rivers are very similar and currently meet Basin Plan objectives and CTR criteria. While the change in trace metal concentrations in the south Delta would likely be measurable, Alternative 7 would not be expected to substantially increase the frequency with which applicable Basin Plan objectives or CTR criteria would be exceeded in the Delta or substantially degrade the quality of Delta waters with regard to trace metals.

SWP/CVP Export Service Areas

For the same reasons stated for the No Action Alternative LLT, Alternative 7 LLT would not result in substantial increases in trace metal concentrations in the water exported from the Delta or diverted from the Sacramento River through the proposed conveyance facilities. As such, there is not expected to be substantial changes in trace metal concentrations in the SWP/CVP export service area waters under Alternative 7, relative to existing conditions, No Action NT, and No Action LLT. As such, Alternative 7 would not be expected to substantially increase the frequency with which applicable Basin Plan objectives or CTR criteria would be exceeded in the water bodies of the affected environment in the SWP and CVP Service Area or substantially degrade the quality of these water bodies, with regard to trace metals.

CEQA Conclusion: There would be no substantial long-term increase in trace metal concentrations in the rivers and reservoirs upstream of the Delta, in the Delta Region, or the SWP/CVP export service area waters under Alternative 7 relative to existing conditions. As such, this alternative is not expected to cause additional exceedance of applicable water quality objectives by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. Because trace metal concentrations are not expected to increase substantially, no long-term water quality degradation for trace metals is expected to occur and, thus, no adverse effects to beneficial uses would occur. Furthermore, any negligible changes in long-term trace metal concentrations that may occur in water bodies of the affected environment would not be expected to make any existing beneficial use impairments measurably worse. The trace metals discussed in this assessment are not considered bioaccumulative, and thus would not directly cause bioaccumulative problems in aquatic life or humans. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-28: Effects on trace metal concentrations resulting from implementation of CM2–CM22

Conservation components under Alternative 7 would be similar to those under Alternative 1A, but 40 linear miles rather than 20 linear miles of channel margin habitat would be enhanced, and 20,000 acres rather than 10,000 acres of seasonally inundated floodplain would be restored. Effects on trace metals resulting from the implementation of CM2-CM22 would be similar to that previously discussed for Alternative 1A. As they pertain to trace metals, implementation of CM2-CM22 would not be expected to adversely affect beneficial uses of the affected environment or substantially degrade water quality with respect to trace metals.

CEQA Conclusion: Implementation of CM2-CM22 under Alternative 7 would not cause substantial long-term increase in trace metal concentrations in the rivers and reservoirs upstream of the Delta, in the Delta Region, or the SWP/CVP export service area. As such, this alternative is not expected to cause additional exceedance of applicable water quality objectives by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. Because trace metal concentrations are not expected to increase substantially, no long-term water quality degradation for trace metals is expected to occur and, thus, no adverse effects to beneficial uses would occur. Furthermore, any negligible changes in long-term trace metal concentrations that may occur throughout the affected environment would not be expected to make any existing beneficial use impairments measurably worse. The trace metals discussed in this assessment are not considered bioaccumulative, and thus would not directly cause bioaccumulative problems in aquatic life or humans. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-29: Effects on TSS and turbidity resulting from facilities operations and maintenance (CM1)

Effects of CM1 on TSS and turbidity under Alternative 7 are the same as those discussed for Alternative 1A LLT. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-30: Effects on TSS and turbidity resulting from implementation of CM2–CM22

Effects of CM2–CM22on TSS and turbidity under Alternative 7 are the same as those discussed for Alternative 1A LLT. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-31: Water quality impacts resulting from construction-related activities for CM1-CM22 implementation

The conveyance features for CM1 under Alternative 7 would be very similar to those discussed for Alternative 1A. The primary difference between Alternative 7 and Alternative 1A is that under Alternative 7, the fewer number of intakes would result in a reduced level of construction activity. Additional construction activity also would occur to restore channel margin and seasonally inundated floodplain habitats. However, construction techniques and locations of major features of the conveyance system within the Delta would be similar. The remainder of the facilities constructed under Alternative 7, including conservation measures CM2-CM22, would be very similar to, or the same as, those to be constructed for Alternative 1A.

The types and magnitude of potential construction-related water quality effects associated with implementation of conservation measures CM1-CM22 under Alternative 7 would be very similar to the effects discussed for Alternative 1A LLT, and the effects anticipated with implementation of CM2-CM22 would be essentially identical. Nevertheless, the construction of CM1 with the environmental commitments and agency permitted construction requirements and BMPs would result in the potential water quality effects being largely avoided and minimized. The specific environmental commitments that would be implemented under Alternative 7 would be similar to those described for Alternative 1A. Consequently, relative to existing conditions, Alternative 7 LLT would not be expected to cause exceedance of applicable water quality objectives/criteria or substantial water quality degradation with respect to constituents of concern, and thus would not adversely affect any beneficial uses upstream of the Delta, in the Delta, or in the SWP and CVP service area.

CEQA Conclusion: Construction-related contaminant discharges would be temporary and intermittent in nature and would involve negligible, if any, discharges of bioaccumulative or 303(d) listed constituents to water bodies of the affected environment. As such, construction activities would not contribute measurably to bioaccumulation of contaminants in organisms or humans or cause 303(d) impairments to be discernibly worse. Because environmental commitments would be implemented under Alternative 7 LLT for construction-related activities along with agency-issues permits that also contain construction requirements to protect water quality, the construction-related effects would not be expected to cause or contribute to a substantial increased frequency of exceedances of water quality objectives/criteria relative to existing conditions, or substantially degrade water quality with respect to the constituents of concern on a long-term average basis, and thus would not adversely affect any beneficial uses in water bodies upstream of the Delta, within the

Delta, or in the SWP and CVP service area. Based on these findings, this impact is determined to be less than significant. No mitigation is required.

8.3.4.13 Alternative 8— Dual Conveyance with Tunnel, Intakes 2, 3, and 5 and Increased Delta Outflow (9,000 cfs; Operational Scenario F)

[*Note to Lead Agencies: Analysis in preparation.*]

Alternative 8 would convey up to 9,000 cfs of water from the north Delta to the south Delta through pipelines/tunnels from three screened intakes on the east bank of the Sacramento River between Clarksburg and Walnut Grove. A new Byron Tract Forebay, adjacent to and south of Clifton Court Forebay, would be constructed which would provide water to the south Delta pumping plants. However, this would be an "isolated" conveyance, no longer involving operation of the existing SWP and CVP south Delta export facilities for Clifton Court forebay and Jones Pumping Plant. Water supply and conveyance operations would follow the guidelines described as Scenario F, which includes fall X2. The alternative would provide up to 1.5 million acre-feet (maf) in increased Delta outflow. Conservation measures 2-23 (CM2-23) would be implemented under this alternative, and would be the same as those under Alternative 1A. See Chapter 3 (Description of Alternatives) for additional details on Alternative 8.

Impact WQ-1: Effects on ammonia concentrations resulting from facilities operations and maintenance (CM1)

Upstream of the Delta

For the same reasons stated for the No Action Alternative LLT, Alternative 8 LLT would have negligible, if any, effect on ammonia concentrations in the rivers and reservoirs upstream of the Delta relative to existing conditions and the No Action Alternative NT and LLT. Any negligible increases in ammonia-N concentrations that could occur in the water bodies of the affected environment located upstream of the Delta would not be of frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the quality of these water bodies, with regard to ammonia.

Delta

SWP/CVP Export Service Areas

Impact WQ-2: Effects on ammonia concentrations resulting from implementation of CM2–CM22

[*Note to Lead Agencies: This assessment is in preparation*].

Impact WQ-3:Effects on boron concentrations resulting from facilities operations and maintenance (CM1)

[*Note to Lead Agencies: This assessment is in preparation*].

Impact WQ-4: Effects on boron concentrations resulting from implementation of CM2–CM22

[*Note to Lead Agencies: This assessment is in preparation*].

Impact WQ-5: Effects on bromide concentrations resulting from facilities operations and maintenance (CM1)

[*Note to Lead Agencies: This assessment is in preparation*].

Upstream of the Delta

Delta

SWP/CVP Export Service Areas

Impact WQ-6: Effects on bromide concentrations resulting from implementation of CM2–CM22

[*Note to Lead Agencies: This assessment is in preparation*].

Impact WQ-7: Effects on chloride concentrations resulting from facilities operations and maintenance (CM1)

[*Note to Lead Agencies: This assessment is in preparation*].

Impact WQ-8: Effects on chloride concentrations resulting from implementation of CM2–CM22

[*Note to Lead Agencies: This assessment is in preparation*].

Impact WQ-9: Effects on dissolved oxygen resulting from facilities operations and maintenance (CM1)

Effects of CM1 on dissolved oxygen under Alternative 8 are the same as those discussed for Alternative 1A LLT. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-10: Effects on dissolved oxygen resulting from implementation of CM2– CM22

Effects of CM2–23 on dissolved oxygen under Alternative 8 are the same as those discussed for Alternative 1A LLT. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-11: Effects on electrical conductivity concentrations resulting from facilities operations and maintenance (CM1)

Impact WQ-12: Effects on electrical conductivity resulting from implementation of CM2-CM22

Effects of CM2-CM22 on EC under Alternative 8 LLT are the same as those discussed for Alternative 1A LLT. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-13: Effects on mercury concentrations resulting from facilities operations and maintenance (CM1)

[*Note to Lead Agencies: This assessment is in preparation*].

Impact WQ-14: Effects on mercury concentrations resulting from implementation of CM2–CM22

[*Note to Lead Agencies: This assessment is in preparation*].

Impact WQ-15: Effects on nitrate concentrations resulting from facilities operations and maintenance (CM1)

[*Note to Lead Agencies: This assessment is in preparation*].

Impact WQ-16: Effects on nitrate concentrations resulting from implementation of CM2–CM22

Impact WQ-17: Effects on dissolved organic carbon concentrations resulting from facilities operations and maintenance (CM1)

[*Note to Lead Agencies: This assessment is in preparation*].

Impact WQ-18: Effects on dissolved organic carbon concentrations resulting from implementation of CM2– CM22

[*Note to Lead Agencies: This assessment is in preparation*].

Impact WQ-19: Effects on pathogens resulting from facilities operations and maintenance

Effects of CM1 on pathogens under Alternative 8 are the same as those discussed for Alternative 1A LLT. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-20: Effects on pathogens resulting from implementation of CM2–CM22

Effects of CM2–CM22on pathogens under Alternative 8 are the same as those discussed for Alternative 1A LLT. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-21: Effects on pesticide concentrations resulting from facilities operations and maintenance (CM1)

[*Note to Lead Agencies: This assessment is in preparation*].

Impact WQ-22: Effects on pesticide concentrations resulting from implementation of CM2–CM22

[*Note to Lead Agencies: This assessment is in preparation*].

Impact WQ-23: Effects on phosphorus concentrations resulting from facilities operations and maintenance (CM1)

[*Note to Lead Agencies: This assessment is in preparation*].

Impact WQ-24: Effects on phosphorus concentrations resulting from implementation of CM2–CM22

[*Note to Lead Agencies: This assessment is in preparation*].

Impact WQ-25: Effects on selenium concentrations resulting from facilities operations and maintenance (CM1)

[*Note to Lead Agencies: This assessment is in preparation*].

Impact WQ-26: Effects on selenium concentrations resulting from implementation of CM2–CM22

[*Note to Lead Agencies: This assessment is in preparation*].

Impact WQ-27: Effects on trace metal concentrations resulting from facilities operations and maintenance (CM1)

[*Note to Lead Agencies: This assessment is in preparation*].

Impact WQ-28: Effects on trace metal concentrations resulting from implementation of CM2–CM22

[*Note to Lead Agencies: This assessment is in preparation*].

Impact WQ-29: Effects on TSS and turbidity resulting from facilities operations and maintenance (CM1)

Effects of CM1 on TSS and turbidity under Alternative 8 are the same as those discussed for Alternative 1A LLT. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-30: Effects on TSS and turbidity resulting from implementation of CM2–CM22

Effects of CM2–CM22on TSS and turbidity under Alternative 8 are the same as those discussed for Alternative 1A LLT. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-31: Water quality impacts resulting from construction-related activities for CM1–CM22 implementation

8.3.4.14 Alternative 9—Separate Corridors (15,000 cfs; Operational Scenario G)

Under Alternative 9, two fish-screened intakes would be constructed – one at the Delta Cross Channel and the other at Georgiana Slough. Water would be conveyed through a flow-collection channel and radial gates, eventually reaching the existing channel. Once in the channel, water would flow south through the Mokelumne River and San Joaquin River to Middle River and Victoria Canal, which would be dredged to accommodate increased flows. Along the way, diverted water would be guided by operable barriers. Water flowing through Victoria Canal would lead into two new canal segments and pass under two existing watercourses through culvert siphons, eventually reaching Clifton Court Forebay. From there, water would flow through existing SWP facilities, and a new canal would be constructed to connect the forebay to CVP facilities. Water supply and conveyance operational criteria under Alternative 9 would be guided by criteria identified in Scenario G. Conservation measures 2-23 (CM2-23) would be implemented under this alternative, and would be the same as those under Alternative 1A. See Chapter 3 (Description of Alternatives) for additional details on Alternative 9.

Impact WQ-1: Effects on ammonia concentrations resulting from facilities operations and maintenance (CM1)

Upstream of the Delta

For the same reasons stated for the No Action Alternative LLT, Alternative 9 LLT would have negligible, if any, effect on ammonia concentrations in the rivers and reservoirs upstream of the Delta relative to existing conditions and the No Action Alternative NT and LLT. Any negligible increases in ammonia-N concentrations that could occur in the water bodies of the affected environment located upstream of the Delta would not be of frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the quality of these water bodies, with regard to ammonia.

Delta

Assessment of effects of ammonia under Alternative 9 LLT is the same as discussed under Alternative 1A, except that because flows in the Sacramento River at Freeport are different between the two alternatives, estimated monthly average and long term annual average predicted ammonia-N concentrations in the Sacramento River downstream of Freeport are different.

As Table 8-61 shows, estimated ammonia-N concentrations in the Sacramento River downstream of Freeport (upon full mixing of the SRWTP discharge with river water) under Alternative 9 LLT and the No Action Alternative LLT are expected to be similar. Minor increases in ammonia-N concentrations would occur during July and August, October, December, January, and in April, and remaining months would be unchanged or have a minor decrease. Annual average concentrations would be the same under both Alternative 9 LLT and the No Action Alternative LLT. Moreover, the estimated concentrations downstream of Freeport under Alternative 9 LLT would be similar to existing source water concentrations for the San Francisco Bay and San Joaquin River. Consequently, changes in source water fraction anticipated under Alternative 9 LLT, relative to the No Action Alternative LLT, are not expected to substantially increase ammonia concentrations at any Delta locations.

Table 8-61. Estimated Ammonia-N (mg-L as N) Concentrations in the Sacramento River Downstream of the Sacramento Regional Wastewaster Treatment Plant for the No Action Alternative LLT and Alternative 9 LLT

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual Average
No Action Alternative LLT	0.081	0.073	0.061	0.055	0.053	0.055	0.061	0.070	0.072	0.064	0.072	0.069	0.063
Alternative 9 LLT	0.084	0.073	0.062	0.056	0.053	0.055	0.062	0.068	0.072	0.066	0.073	0.068	0.063

Any negligible increases in ammonia-N concentrations that could occur at certain locations in the Delta would not be of frequency, magnitude, and geographic extent that would adversely affect any beneficial uses or substantially degrade the water quality at these locations, with regards to ammonia.

SWP/CVP Export Service Areas

The assessment of effects on ammonia in the SWP/CVP Export Service Area is based on assessment of ammonia-N concentrations at Banks and Jones pumping plants. Similar to the discussion for Alternative 1A, under Alternative 9 for areas of the Delta that are influenced by Sacramento River water, including Banks and Jones pumping plants, ammonia-N concentrations are expected to decrease, relative to existing conditions and No Action Alternative NT. This decrease in ammonia-N concentrations for water exported via the south Delta pumps is not expected to result in an adverse effects on beneficial uses or substantially degrade water quality of exported water, with regards to ammonia.

Furthermore, as discussed above for the Plan Area, for all areas of the Delta, including Banks and Jones pumping plants, ammonia-N concentrations are not expected to be substantially different under Alternative 9 LLT, relative to No Action Alternative LLT. Any negligible increases in ammonia-N concentrations that could occur at Banks and Jones pumping plants would not be of frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the water quality at these locations, with regards to ammonia.

***CEQA Conclusion*:** There would be no substantial, long-term increase in ammonia-N concentrations in the rivers and reservoirs upstream of the Delta, in the PlanArea, or the waters exported to the CVP and SWP service areas under Alternative 9 LLT relative to existing conditions. As such, this alternative is not expected to cause additional exceedance of applicable water quality objectives/criteria by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. Because ammonia concentrations are not expected to increase substantially, no long-term water quality degradation is expected to occur and, thus, no adverse effects on beneficial uses would occur. Ammonia is not 303(d) listed within the affected environment and thus any minor increases than could occur in some areas would not make any existing ammonia-related impairment measurably worse because no such impairments currently exist. Because ammonia-N is not bioaccumulative, minor increases that could occur in some areas would not bioaccumulate to greater levels in aquatic organisms that would, in turn, pose substantial health risks to fish, wildlife, or humans. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-2: Effects on ammonia concentrations resulting from implementation of CM2–CM22

Effects of CM2–CM22on ammonia under Alternative 9 LLT are the same as those discussed for Alternative 1A LLT. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-3:Effects on boron concentrations resulting from facilities operations and maintenance (CM1)

Upstream of the Delta

Effects of CM1 on boron under Alternative 9 LLT in areas upstream of the Delta would be very similar to the effects discussed for Alternative 1A LLT. There would be no expected change to the sources of boron in the Sacramento and east-side tributary watersheds, and resultant changes in flows from altered system-wide operations would have negligible, if any, effects on the concentration of boron in the rivers and reservoirs of these watersheds. The modeled long-term annual average lower San Joaquin River flow at Vernalis would decrease slightly compared to existing conditions and the No Action Alternative NT, and would be similar compared to the No Action Alternative LLT. The reduced flow would result in possible increases in long-term average boron concentrations of up to about 3% relative to the existing conditions and No Action Alternative NT conditions. The increased boron concentrations would not increase the frequency of exceedances of any applicable objectives or criteria and would not be expected to cause further degradation at measurable levels in the lower San Joaquin River, and thus would not cause the existing impairment there to be discernibly worse. Consequently, Alternative 9 LLT would not be expected to cause exceedance of boron objectives/criteria or substantially degrade water quality with respect to boron, and thus would not adversely affect any beneficial uses of the Sacramento River, the east-side tributaries, associated reservoirs upstream of the Delta, or the San Joaquin River.

Delta

Relative to the existing conditions, No Action Alternative NT, and No Action Alternative LLT, Alternative 9 LLT would result in similar or reduced long-term average boron concentrations for the 16-year period modeled at northern and eastern Delta locations, with a substantial reduction in boron concentrations in the San Joaquin River at Buckley Cove. Long-term average boron concentrations would increase at interior and western Delta locations (by as much as 66% at Franks Tract, 82% at Old River at Rock Slough, and 13% at the Sacramento River at Emmaton) (Appendix 8F, Table Bo-22). Implementation of tidal habitat restoration under conservation measure CM4 also may contribute to increased boron concentrations at western Delta assessment locations, and thus would not be anticipated to substantially affect agricultural diversions which occur primarily at interior Delta locations. The long-term annual average and monthly average boron concentrations, for either the 16-year period or drought period modeled, would never exceed the 2,000 μg/L human health advisory objective (i.e., for children) or 500 μg/L agricultural objective at any of the eleven Delta assessment locations, which represents no change from the existing conditions and No Action Alternative NT and LLT conditions (Appendix 8F, Table Bo-3). The increased concentrations at interior Delta locations would result in moderate reductions in the long-term average assimilative capacity of up to 33% at Franks Tract and up to 47% at Old River at Rock Slough locations (Appendix 8F, Table Bo-23). However, because the absolute boron concentrations would still be well below the lowest 500 μg/L objective for the protection of the agricultural beneficial use under Alternative 9 LLT, the levels of boron degradation would not be of sufficient magnitude to substantially increase the risk of exceeding objectives or cause adverse effects to municipal and agricultural water supply beneficial uses, or any other beneficial uses, in the Delta (Appendix 8F, Figure Bo-4).

SWP/CVP Export Service Areas

Effects of CM1 on boron under Alternative 9 LLT in the Delta would be very similar to the effects discussed for Alternative 1A LLT. Under Alternative 9 LLT, long-term average boron concentrations would decrease by as much as 18% at the Banks Pumping Plant and by as much 31% at Jones Pumping Plant relative to existing conditions, No Action Alternative NT, and No Action Alternative LLT (Appendix 8F, Table Bo-22). Commensurate with the decrease in exported boron concentrations, boron concentrations in the lower San Joaquin River may be reduced and would likely alleviate or lessen any expected increase in boron concentrations at Vernalis associated with flow reductions (see discussion of Upstream of the Delta), as well locations in the Delta receiving a large fraction of San Joaquin River water. Reduced export boron concentrations also may contribute to reducing the existing 303(d) impairment in the lower San Joaquin River and associated TMDL actions for reducing boron loading.

Maintenance of SWP and CVP facilities under Alternative 9 LLT would not be expected to create new sources of boron or contribute towards a substantial change in existing sources of boron in the affected environment. Maintenance activities would not be expected to cause any substantial increases in boron concentrations or degradation with respect to boron such that objectives would be exceeded more frequently, or any beneficial uses would be adversely affected anywhere in the affected environment.

CEQA Conclusion: Boron is not a bioaccumulative constituent, thus any increased concentrations under Alternative 9 LLT would not result in adverse boron bioaccumulation effects to aquatic life or humans. Relative to existing conditions, Alternative 9 LLT would not result in any substantial increases in boron concentration upstream of the Delta. Alternative 9 LLT maintenance also would not result in any substantial increases in boron concentrations in the affected environment. Relative to existing conditions, Alternative 9 LLT would not result in substantially increased boron concentrations such that frequency of exceedances of municipal and agricultural water supply objectives would increase. The levels of boron degradation that may occur under Alternative 9 LLT, while widespread in particular at interior Delta locations, would not be of sufficient magnitude to cause substantially increased risk for adverse effects to municipal or agricultural beneficial uses within the affected environment. Long-term average boron concentrations would decrease in Delta water exports to the SWP and CVP service area, which may contribute to reducing the existing 303(d) impairment of agricultural beneficial uses in the lower San Joaquin River. Consequently, Alternative 9 LLT would not be expected to cause any substantial increases in boron concentrations or degradation with respect to boron such that objectives would be exceeded more frequently, or any beneficial uses would be adversely affected anywhere in the affected environment. Based on these findings, this impact is determined to be less than significant. No mitigation is required.

Impact WQ-4: Effects on boron concentrations resulting from implementation of CM2–CM22

Effects of CM2-CM22 on boron under Alternative 9 LLT are the same as those discussed for Alternative 1A LLT. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-5: Effects on bromide concentrations resulting from facilities operations and maintenance (CM1)

Upstream of the Delta

Under Alternative 9 LLT there would be no expected change to the sources of bromide in the Sacramento and eastside tributary watersheds. Bromide loading in these watersheds would remain unchanged and resultant changes in flows form altered system-wide operations under Alternative 9 LLT would have negligible, if any, effects on the concentration of bromide in the rivers and reservoirs of these watersheds. Consequently, Alternative 9 LLT would not be expected to adversely affect the MUN beneficial use, or any other beneficial uses, of the Sacramento River, the eastside tributaries, or their associated reservoirs upstream of the Delta.

Under Alternative 9 LLT, modeling indicates that long-term annual average flows on the San Joaquin River would decrease by 6%, relative to existing conditions, 5% relative to No Action Alternative NT, and would remain virtually the same relative to No Action Alternative LLT. Similar to the No Action Alternative LLT, these decreases in flow would result in possible increase in long-term average bromide concentrations of about 3%, relative to existing conditions, 2% relative to No Action Alternative NT, and less than <1% relative to No Action Alternative LLT. The small increases in lower San Joaquin River bromide levels that could occur under Alternative 9 LLT, relative to existing, No Action Alternative NT, and No Action Alternative LLT conditions would not be expected to adversely affect the MUN beneficial use, or any other beneficial uses, of the lower San Joaquin River.

Delta

Relative to existing conditions, Alternative 9 LLT would result in increases in long-term average bromide concentrations at Buckley Cove (for the modeled drought period only), Emmaton, and Barker Slough, while long-term average concentrations would decrease at the other assessment locations (Appendix 8E, Bromide Table 20-21). With regard to bromide, Emmaton is a suitable source of raw drinking water on a seasonal basis. While the relative change in long-term average bromide concentration at Emmaton is considerable (≤32%), the increase in the average would be due to more frequent seasonal peak concentrations in excess of 1,000 µg/L relative to existing conditions (Appendix 8E, Bromide Figure 8). At Emmaton the predicted 50 µg/L exceedance frequency would increase only slightly from 82% under existing conditions to 86% under Alternative 9 LLT (98% to 100% for the modeled drought period), and the predicted 100 µg/L exceedance frequency would increase from 72% under existing conditions to 81% under Alternative 9 LLT (93% to 97% for the modeled drought period), indicative of very small changes during seasonally suitable periods of potential use. At Barker Slough, predicted long-term average bromide concentrations would increase from 51 µg/L to 61 µg/L (19% relative increase) for the modeled 16-year hydrologic period and 54 µg/L to 100 µg/L (88% relative increase) for the modeled drought period. At Barker Slough, the predicted 50 µg/L exceedance frequency would decrease from 49% under existing conditions to 41% under Alternative 9 LLT, but would increase from 55% to 80% during the drought period. At Barker Slough, the predicted 100 µg/L exceedance frequency would increase from 0% under existing conditions to 16% under Alternative 9 LLT, and would increase from 0% to 42% during the drought period. At Buckley Cove, predicted long-term average bromide concentrations would remain the same (i.e., 259 µg/L), but would increase from 272 µg/L to 330 µg/L (21% relative increase) for the modeled drought period. At Buckley Cove, the predicted 50 µg/L exceedance frequency would not change (i.e., 100% exceedance), but the modeled 100 µg/L exceedance frequency would decrease from 100% under existing conditions to 90% under Alternative 9 LLT (100% to 87% for the modeled drought period).

Due to the relatively small differences between modeled existing conditions and No Action baselines, changes in long-term average bromide concentrations and changes inexceedance frequencies relative to No Action Alternative NT and No Action Alternative LLT are generally of similar magnitude to those previously described for the existing condition comparison (Appendix 8E, Bromide Table 20-21). Modeled long-term average bromide concentration at Emmaton would increase by as much as 36%, but change in 50 and 100 µg/L exceedance thresholds would be smaller than that described for the existing condition comparison, indicative of very small changes during seasonally suitable periods of potential use. Modeled long-term average bromide concentration at Barker Slough is predicted to increase by 25% (92% for the modeled drought period) relative to No Action Alternative NT, and would increase by 23% (87% for the modeled drought period) relative to No Action Alternative LLT. Modeled long-term average bromide concentration increases at Buckley Cove are predicted to increase by 6% (35% for the modeled drought period) relative to No Action Alternative NT, and would increase by 7% (36% for the modeled drought period) relative to No Action Alternative LLT.

While the increase in long-term average bromide concentrations at Buckley Cove are relatively small when modeled over a representative 16-year hydrologic period, increases during the modeled drought period, principally the long-term average bromide concentration greater than 300 μg/L, would represent a substantial change in source water quality to the City of Stockton during a season of drought. Additionally, the increase in long-term average bromide concentrations predicted at Barker Slough, principally the relative increase in 100 μg/L exceedance frequency, would result in a substantial change in source water quality for existing drinking water treatment plants drawing water from the North Bay Aqueduct. While the implications of such modeled changes in bromide concentrations at Buckley Cove and Barker Slough is difficult to predict, the substantial modeled increases could lead to adverse changes in the formation of disinfection byproducts such that considerable treatment plant upgrades may be necessary in order to achieve equivalent levels of health protection.

The seasonal intakes at Mallard Slough and City of Antioch are infrequently used due to water quality constraints related to sea water intrusion. On a long-term average basis, bromide at these locations is in excess of 3,000 μg/L, but during seasonal periods of high Delta outflow can be <300 μg/L. Use of the seasonal intakes at Mallard Slough and City of Antioch under Alternative 9 LLT would experience a period average increase in bromide during the months when these intakes would most likely be utilized. For those wet and above normal water year types where mass balance modeling would predict water quality typically suitable for diversion, predicted long-term average bromide would increase from 103 μg/L to 140 μg/L (37% increase) at City of Antioch and would decrease from 150 μg/L to 146 μg/L (3% decrease) at Mallard Slough relative to existing conditions (Appendix 8E, Bromide Figure 6-7). Changes would be similar for No Action Alternative NT and No Action Alternative LLT comparison. The decisions surrounding the use of these seasonal intakes is largely driven by acceptable water quality, and thus have historically been opportunistic. Opportunity to use these intakes would remain, and the predicted increases in bromide concentrations at the City of Antioch and Mallard Slough intake would not be expected to adversely affect MUN beneficial uses, or any other beneficial use, at these locations.

Relative to existing, No Action Alternative NT, and No Action Alternative LLT conditions, Alternative 9 LLT would lead to predicted improvements in long-term average bromide concentrations at Staten Island, Franks Tract, Rock Slough, and Contra Costa PP No. 1, in addition to Banks and Jones (discussed below). At Staten Island and Franks Tract, long-term average bromide concentrations would be predicted to decrease by 4-21% depending on baseline comparison, while at Rock Slough and Contra Costa PP No.1, long-term average bromide concentrations would be predicted to decrease by 40-45%, depending on baseline comparison.

SWP/CVP Export Service Areas

Under Alternative 9 LLT, improvement in long-term average bromide concentrations would occur at the Banks and Jones pumping plants, with exception to the modeled drought period when compared to No Action Alternative NT and No Action Alternative LLT. Long-term average bromide concentrations for the modeled 16-year hydrologic period at these locations would decrease by as much as 21% relative to existing conditions, 12% relative to No Action Alternative NT, and 9% relative to No Action Alternative LLT (Appendix 8E, Bromide Tables 20-21). However, during the modeled drought period, long-term average bromide concentrations would increase by as much as 7% relative to No Action Alternative NT, and 12% relative to No Action Alternative LLT. Exceedances of the 50 μg/L assessment threshold would remain virtually the same for both Banks and Jones, but exceedance of the 100 μg/L assessment threshold would decrease, from 100% to 81% at Banks and from 100% to 80% at Jones (100% to 77% for the modeled drought period at both Banks and Jones. Lower long-term average bromide concentrations at Banks and Jones would result in overall improvement in Export Service Areas water quality respective to bromide. Commensurate with the decrease in exported bromide, an improvement in lower San Joaquin River bromide would also be observed since bromide in the lower San Joaquin River is principally related to irrigation water deliveries from the Delta. While the magnitude of this expected lower San Joaquin River improvement in bromide is difficult to predict, the relative decrease in overall loading of bromide to the Export Service Areas would likely alleviate or lessen any expected increase in bromide concentrations at Vernalis (see discussion of Upstream of the Delta) as well locations in the Delta receiving a large fraction of San Joaquin River water, such as much of the south Delta.

Similar to the discussion pertaining to the No Action Alternative LLT, maintenance of SWP and CVP facilities under Alternative 9 LLT would not be expected to create new sources of bromide or contribute towards a substantial change in existing sources of bromide in the affected environment. Maintenance activities would not be expected to cause any substantial change in bromide such that MUN beneficial uses, or any other beneficial use, would be adversely affected anywhere in the affected environment.

***CEQA Conclusion*:** Relative to existing conditions, Alternative 9 LLT operation and maintenance would not result in any substantial change in long-term average bromide concentration upstream of the Delta. Furthermore, under Alternative 9 LLT, water exported from the Delta to the SWP/CVP service area would be substantially improved relative to bromide. Bromide is not bioaccumulative, therefore change in long-term average bromide concentrations would not directly cause bioaccumulative problems in aquatic life or humans. Additionally, bromide is not a constituent related to any 303(d) listings. Alternative 9 LLT operation and maintenance activities would not cause substantial long-term degradation to water quality respective to bromide with the exception of water quality at Buckley Cove (drought period only) and Barker Slough. At Buckley Cove, modeled long-term annual average concentrations of bromide would increase from 272 µg/L to 330 µg/L (21% relative increase) during the modeled drought period. At Barker Slough, modeled long-term annual average concentrations of bromide would increase from 54 µg/L to 100 µg/L (88% relative increase) for the modeled drought period. Furthermore, for Barker Slough the frequency of predicted bromide concentrations exceeding 100 µg/L would increase from 0% under existing conditions to 16% under Alternative 9 LLT (0% to 42% for the modeled drought period). Substantial changes in long-term average bromide at these locations could necessitate changes in treatment plant operation or require treatment plant upgrades in order to maintain DBP compliance. The model predicted change at Buckley Cove during the drought period and at Barker Slough is substantial and, therefore, would represent a substantially increased risk for adverse effects on existing MUN beneficial uses should treatment upgrades not be undertaken. The impact is considered significant and mitigation is required. Implementation of Mitigation Measure WQ-5 would reduce identified impacts to a less than significant level at Barker Slough by relocating the North Bay Aqueduct outside the influence of sea water intrusion. However, there is no feasible mitigation available for identified impacts at Buckley Cove.

Mitigation Measure WQ-5: Move the North Bay Aqueduct intake from Barker Slough to the Sacramento River

Please see Mitigation Measure WQ-5 under Impact WQ-5 in the discussion of Alternative 1A.

Impact WQ-6: Effects on bromide concentrations resulting from implementation of CM2–CM22

Conservation components under Alternative 9 LLT would be similar to those under Alternative 1A, but with changes in the south Delta to accommodate the modified corridors. As discussed for Alternative 1A LLT, implementation of the CM2-CM would not present new or substantially changed sources of bromide to the project area. Some conservation measures may replace or substitute for existing irrigated agriculture in the Delta. This replacement or substitution is not expected to substantially increase or present new sources of bromide. CM2-CM22 would not be expected to cause any substantial change in bromide such that MUN beneficial uses, or any other beneficial use, would be adversely affected anywhere in the affected environment.

CEQA Conclusion: Conservation components proposed under Alternative 9 LLT would be similar to those proposed under Alternative 1A LLT. As discussed for Alternative 1A LLT, implementation of CM2-CM22 would not present new or substantially changed sources of bromide to the project area. As such, effects on bromide resulting from the implementation of CM2-CM22 would be similar to that previously discussed for Alternative 1A LLT. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-7: Effects on chloride concentrations resulting from facilities operations and maintenance (CM1)

Upstream of the Delta

Under Alternative 9 LLT there would be no expected change to the sources of chloride in the Sacramento and eastside tributary watersheds. Chloride loading in these watersheds would remain unchanged and resultant changes in flows from altered system-wide operations would have negligible, if any, effects on the concentration of chloride in the rivers and reservoirs of these watersheds. The modeled long-term annual average flows on the lower San Joaquin River at Vernalis would decrease slightly compared to existing conditions and the No Action Alternative NT, and be similar compared to the No Action Alternative LLT. The reduced flow would result in possible increases in long-term average chloride concentrations of about 2%, relative to the existing conditions and No Action Alternative NT conditions, and no change relative to No Action Alternative LLT. Consequently, Alternative 9 LLT would not be expected to cause exceedance of chloride objectives/criteria or substantially degrade water quality with respect to chloride, and thus would not adversely affect any beneficial uses of the Sacramento River, the eastside tributaries, associated reservoirs upstream of the Delta, or the San Joaquin River.

Delta

Relative to the existing conditions, No Action Alternative NT, and No Action Alternative LLT, Alternative 9 LLT would result in similar or reduced long-term average chloride concentrations for the 16-year period modeled at nine of the assessment locations, and increased concentrations at the North Bay Aqueduct at Barker Slough (up to 20% compared to No Action Alternative NT), Sacramento River at Emmaton (up to 38% compared to No Action Alternative NT), and Sacramento River at Mallard Island (up to 4% compared to No Action Alternative NT) (Appendix 8G, Chloride Table Cl-37). Moreover, the direction and magnitude of predicted changes for Alternative 9 LLT are similar between the alternatives, thus, the effects relative to existing conditions and the No Action Alternative scenarios are discussed together. Additionally, implementation of tidal habitat restoration under conservation measure CM4 would increase the tidal exchange volume in the Delta, and thus may contribute to increased chloride concentrations in the Bay source water as a result of increased salinity intrusion. Consequently, while uncertain, the magnitude of chloride increases may be greater than indicated herein and would affect the western Delta assessment locations the most which are influenced to the greatest extent by the Bay source water. The following outlines the modeled chloride changes relative to the applicable objectives and beneficial uses of Delta waters.

Municipal Beneficial Uses

Relative to the 150 mg/L Bay-Delta WQCP objective for municipal and industrial beneficial uses, the plots of monthly average chloride concentrations at the Contra Costa Canal at Pumping Plant #1 for the separate water year types indicates that the number of months above the objective would decrease substantially compared to the existing conditions, No Action Alternative NT, and No Action Alternative LLT, thus indicating complete compliance with this objective would be achieved (Appendix 8G, Figure Cl-11). The modeled chloride concentrations at the San Joaquin River at Antioch location would never meet this objective; however, this represents no change from the existing conditions, No Action Alternative NT, and No Action Alternative LLT.

With respect to the 250 mg/L Bay-Delta WQCP objective, the modeled frequency of exceedances based on monthly average chloride concentrations for the 16-year period modeled would be eliminated at the Contra Costa Canal at Pumping Plant #1 (24% for existing conditions to 0% under Alternative 9), thus indicating complete compliance with this objective would be achieved (Appendix 8G, Table Cl-38 and Figure Cl-12). Compared to existing conditions, the frequency of exceedances would not change substantially at the San Joaquin River (i.e., increase of 2% from 66% to 68%) or at Mallard Island (up 1%) and would decrease compared to the No Action Alternative NT and No Action Alternative LLT scenarios (Appendix 8G, Table Cl-38), and there would be no substantial long-term degradation (Appendix 8G, Table Cl-39). Consequently, Alternative 9 LLT would not be expected to cause any substantial change in chloride concentrations or degradation, thus, the municipal and industrial water supply beneficial uses would not be adversely affected.

Aquatic Life Beneficial Uses

Relative to the 230 mg/L chronic EPA aquatic life criterion, monthly average chloride concentrations would not exceed the criterion at northern and eastern Delta locations, and the frequency of exceedances would decrease at the interior and southern Delta locations compared to the existing conditions, No Action Alternative NT, and No Action Alternative LLT (Appendix 8G, Table Cl-38 and Figure Cl-13) and no substantial long-term degradation (Appendix 8G, Table Cl-40). Consequently, Alternative 9 LLT would result in improved chloride conditions with respect to aquatic life beneficial uses.

303(d) Listed Water Bodies

With respect to the 303(d) listing for chloride in Tom Paine Slough, the monthly average chloride concentrations for the 16-year period modeled at Old River at Tracy Road would generally be similar compared to existing conditions, and thus, would not be further degraded on a long-term basis (Appendix 8G, Figure Cl-13). With respect to Suisun Marsh, the monthly average chloride concentrations for the 16-year period modeled would generally increase compared to existing conditions No Action Alternative NT, and No Action Alternative LLT in some months during October through May at the Sacramento River at Collinsville (Appendix 8G, Figure Cl-14), Mallard Island (Appendix 8G, Figure Cl-12), and increase substantially at Montezuma Slough at Beldon's Landing (i.e., over a doubling of concentration in December through February) (Appendix 8G, Figure Cl-15), thereby contributing to additional, measureable long-term degradation that potentially would adversely affect the necessary actions to reduce chloride loading for any TMDL that is developed.

SWP/CVP Export Service Areas

Under Alternative 9 LLT, long-term average chloride concentrations for the 16-year period modeled at the Banks and Jones pumping plants would decrease by as much as 21% relative to existing conditions, 12% relative to No Action Alternative NT, and 10% compared to No Action Alternative LLT (Appendix 8G, Chloride Table Cl-37). The modeled frequency of exceedances of applicable water quality objectives/criteria would decrease relative to existing conditions, No Action Alternative NT, and No Action Alternative LLT, for both the 16-year period and the drought period modeled (Appendix 8G, Chloride Table Cl-38). Consequently, water exported into the SWP/CVP service area would generally be of similar or better quality with regards to chloride relative to existing conditions and the No Action Alternative NT and No Action Alternative LLT conditions.

Commensurate with the reduced chloride concentrations in water exported to the service area, reduced chloride loading in the lower San Joaquin River would be anticipated which would likely alleviate or lessen any expected increase in chloride at Vernalis related to decreased annual average San Joaquin River flows (see discussion of Upstream of the Delta).

Maintenance of SWP and CVP facilities would not be expected to create new sources of chloride or contribute towards a substantial change in existing sources of chloride in the affected environment. Maintenance activities would not be expected to cause any substantial change in chloride such that any long-term water quality degradation would occur, thus, beneficial uses would not be adversely affected anywhere in the affected environment.

CEQA Conclusion: Chloride is not a bioaccumulative constituent, thus any increased concentrations under Alternative 9 LLT would not result in adverse chloride bioaccumulation effects on aquatic life or humans. Alternative 9 LLT maintenance would not result in any substantial changes in chloride concentration upstream of the Delta or in the SWP/CVP service area. Relative to existing conditions, Alternative 6A LLT operations would result in substantially reduced chloride concentrations such that exceedances of the 250 mg/L Bay-Delta WQCP objective at the San Joaquin River at Antioch and Mallard Slough would be reduced. However, relative to the existing conditions, the modeled increased chloride concentrations and degradation in the western Delta could still occur and further contribute, at measurable levels (i.e., over a doubling of concentration), to the existing 303(d) listed impairment due to chloride in Suisun Marsh for the protection of fish and wildlife. Based on these findings, this impact is determined to be potentially significant due to increased chloride concentrations and potential adverse effects on fish and wildlife beneficial uses in Suisun Marsh.

While implementation of Mitigation Measure WQ-7 may reduce this impact, the feasibility and effectiveness of this mitigation measures is uncertain. Therefore, the available mitigation would not necessarily reduce the impact to a level that would be less than significant.

Mitigation Measure WQ-7: Conduct additional evaluation and modeling of increased chloride levels and develop and implement phased actions to reduce levels

Please see Mitigation Measure WQ-7 under Impact WQ-7 in the discussion of Alternative 1A.

Because Alternative 9 would not result in adverse effects on municipal and industrial water supply beneficial uses in the western Delta, the emphasis and mitigation actions would be limited to those necessary to reduce or avoid adverse effects on Suisun Marsh.

Impact WQ-8: Effects on chloride concentrations resulting from implementation of CM2–CM22

Under Alternative 9 LLT, the types and geographic extent of effects on chloride concentrations in the Delta as a result of implementation of the other conservation measures (i.e., CM2-22) would be similar to, and undistinguishable from, those effects previously described for Alternative 1A LLT. The conservation measures would present no new direct sources of chloride to the affected environment. Moreover, some habitat restoration conservation measures (CM4-10) would occur on lands within the Delta currently used for irrigated agriculture, thus replacing agricultural land uses with restored tidal wetlands, floodplain, and related channel margin and off-channel habitats. The potential reduction in irrigated lands within the Delta may result in reduced discharges of agricultural field drainage with elevated chloride concentrations, which would be considered an improvement compared to existing conditions.

CEQA Conclusion: Implementation of the CM2-CM22 for Alternative 9 LLT would not present new or substantially changed sources of chloride to the affected environment upstream of the Delta, within Delta, or in the SWP/CVP service area. Replacement of irrigated agricultural land uses in the Delta with habitat restoration conservation measures may result in some reduction in discharge of agricultural field drainage with elevated chloride concentrations, thus resulting in improved water quality conditions. Based on these findings, this impact is considered to be less than significant. No mitigation is required.

Impact WQ-9: Effects on dissolved oxygen resulting from facilities operations and maintenance (CM1)

Effects of CM1 on dissolved oxygen under Alternative 9 are the same as those discussed for Alternative 1A LLT. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-10: Effects on dissolved oxygen resulting from implementation of CM2-CM22

Effects of CM2–23 on dissolved oxygen under Alternative 9 are the same as those discussed for Alternative 1A LLT. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-11: Effects on electrical conductivity concentrations resulting from facilities operations and maintenance (CM1)

Upstream of the Delta

For the same reasons stated for the No Action Alternative LLT, EC levels (highs, lows, typical conditions) in the Sacramento River and its tributaries, the eastside tributaries, their associated reservoirs, and the San Joaquin River upstream ofthe Delta under Alternative 9 LLT are not expected to be outside the ranges occurring under existing conditions or would occur under the No Action Alternative NT and LLT. Any minor changes in EC levels that could occur under Alternative 9 LLT in water bodies upstream of the Delta would not be of sufficient magnitude, frequency and geographic extent that would cause adverse effects on beneficial uses or substantially degrade water quality with regard to EC.

Delta

Relative to existing conditions, Alternative 9 LLT would result in an increase in the number of days the Bay-Delta WQCP EC objectives would be exceeded in the San Joaquin River at San Andreas

Landing (Appendix H, Table EC-9). The percent of days the San Andreas Landing EC objective would be exceeded for the entire period modeled (1976-1991) would be 1% under existing conditions and Alternative 9 LLT, and the percent of days out of compliance with the EC objective would increase from 1% under existing conditions to 2% under Alternative 9 LLT. Average EC levels at the western and southern Delta compliance locations and S. Fork Mokelumne River at Terminous (an interior Delta location) would decrease from 1-33% for the entire period modeled and 2-33% during the drought period modeled (1987-1991) (Appendix H, Table EC-20). In the San Joaquin River at San Andreas Landing, average EC would increase 16% for the entire period modeled and 33% during the drought period modeled. Average EC in the San Joaquin River at San Andreas Landing would increase during all months (Appendix H, Table EC-20). In the San Joaquin River at Prisoners Point, average EC would increase 2% for the entire period modeled and 16% during the drought period modeled. Average EC in at Prisoners Point would increase in September through December (Appendix H, Table EC-20). None of the compliance locations in the western, northwestern, and southern portions of the Delta – which are the Clean Water Act section 303(d) listed regions of the Delta – would have an increased frequency of exceedance of the Bay-Delta WQCP objectives (Appendix H, Table EC-9) and long-term average EC levels at compliance locations in these regions would decrease relative to existing conditions (Appendix H, Table EC-20). Thus, Alternative 9 LLT is not expected to contribute to additional impairment and potentially adversely affect beneficial uses for section 303(d) listed Delta waterways, relative to existing conditions.

Relative to the No Action Alternative NT, the change in percent compliance with Bay-Delta WQCP EC objectives under Alternative 9 LLT would be similar to that described above relative to existing conditions. The exception is that in the San Joaquin River at Vernalis there would also be a slight increase (from 2% to 3%) in the percent of days the EC objective would be exceeded for the entire period modeled. For the entire period modeled, average EC levels would increase in the San Joaquin River at San Andreas Landing, Vernalis, and Prisoners Point. The greatest average EC increase would occur in the San Joaquin River at San Andreas Landing (26%); the increase at the other locations would be 3% at Vernalis and 11% at Prisoners Point (Appendix H, Table EC-20). Similarly, during the drought period modeled, average EC would increase at these locations. The greatest average EC increase during the drought period modeled also would occur in the San Joaquin River at San Andreas Landing (43%); the average EC increase at the other locations would be 1% at Vernalis and 26% at Prisoners Point (Appendix H, Table EC-20). Given that the southern Delta is Clean Water Act section 303(d) listed as impaired due to elevated EC, the increase in the incidence of exceedance of EC objectives and increase in long-term and drought period average EC under Alternative 9 LLT at Vernalis, relative to the No Action Alternative NT, has the potential to contribute to additional impairment and potentially adversely affect beneficial uses.

Relative to the No Action Alternative LLT, the locations with an increased frequency of exceedance of the Bay-Delta WQCP EC objectives under Alternative 9 LLT would similar to that described relative to existing conditions (Appendix H, Table EC-9). Average EC would increase in the San Joaquin River at San Andreas Landing and Prisoners Point similar to that described above relative to the No Action Alternative NT. None of the compliance locations in the western, northwestern, and southern portions of the Delta – which are the Clean Water Act section 303(d) listed regions of the Delta – would have an increased frequency of exceedance of the Bay-Delta WQCP objectives (Appendix H, Table EC-9) and long-term average EC levels at compliance locations in these regions would decrease relative to the No Action Alternative LLT (Appendix H, Table EC-20). Thus, Alternative 9 LLT is not expected to contribute to additional impairment and potentially adversely affect beneficial uses for section 303(d) listed Delta waterways, relative to the No Action Alternative LLT.

For Suisun Marsh, October-May is the period when Bay-Delta WQCP EC objectives for protection of fish and wildlife apply. Long-term average EC would increase under Alternative 7 LLT, relative to existing conditions, during the months of December through May by 0.2-0.4 mS/cm in the Sacramento River at Collinsville (Appendix H, Table EC-21). In Montezuma Slough at National Steel during January and February, long-term average EC would increase 0.1-0.2 mS/cm (Appendix H, Table EC-22). The most substantial increase would occur near Beldon Landing, with long-term average EC levels increasing by 1.5-6.3 mS/cm, depending on the month, nearly doubling and tripling during some months the long-term average EC relative to existing conditions (Appendix H, Table EC-23). Sunrise Duck Club and Volanti Slough also would have long-term average EC increases during February-May of 1.5-3.9 mS/cm (Appendix H, Tables EC-24 and EC-25). The degree to which the long-term average EC increases would cause exceedance of Bay-Delta WQCP objectives is unknown, because objectives are expressed as a monthly average of daily high tide EC, which does not have to be met if it can be demonstrated "equivalent or better protection will be provided at the location" (State Water Resources Control Board 2006:14). The described long-term average EC increase may, or may not, contribute to adverse effectson beneficial uses, depending on how and when wetlands are flooded, soil leaching cycles, and how recirculation of water is managed, and future actions taken with respect to the marsh. However, the EC increases at certain locations would be substantial and it is uncertain the degree to which current management plans for the Suisun Marsh would be able to address these substantially higher EC levels and protect beneficial uses. Thus, these increased EC levels in Suisun Marsh are considered to have a potentially adverse effect on marsh beneficial uses. Long-term average EC increases in Suisun Marsh under Alternative 9 LLT relative to the No Action Alternative NT and LLT would be similar to the increases relative to existing conditions. Suisun Marsh is section 303(d) listed as impaired due to elevated EC, and the potential increases in long-term average EC concentrations could contribute to additional impairment, because the increases would be double or triple that relative to existing conditions and the No Action Alternative NT and LLT.

SWP/CVP Export Service Areas

At the Banks and Jones pumping plants, Alternative 9 LLT would result in no exceedances of the Bay-Delta WQCP's 1,000 μmhos/cm EC objective for the entire period modeled (Appendix H, Table EC-10). Thus, there would be no adverse effect to the beneficial uses in the SWP/CVP Export Service Areas using water pumped at this location under the Alternative 9 LLT.

At the Banks pumping plant, relative to existing conditions, average EC levels under Alternative 9 LLT would decrease substantially on average: 56% for the entire period modeled and 62% during the drought period modeled. Relative to the No Action Alternative NT, average EC levels would decrease by 53% for the entire period modeled and 60% during the drought period modeled. Similar decreases in EC would occur relative to the No Action Alternative LLT. (Appendix H, Table EC-20)

At the Jones pumping plant, relative to existing conditions, average EC levels under Alternative 9 LLT would also decrease on average, but to a lesser degree: 22% for the entire period modeled and 18% during the drought period modeled. Relative to the No Action Alternative NT, average EC levels would decrease by 16% for the entire period modeled and 13% during the drought period modeled.

Similar decreases in average EC would occur relative to the No Action Alternative LLT. (Appendix H, Table EC-20)

Based on the decreases in long-term average EC levels that would occur at the Banks and Jones pumping plants, Alternative 9 LLT would not cause degradation of water quality with respect to EC in the SWP/CVP Export Service Areas; rather, Alternative 9 LLT would improve long-term average EC conditions in the SWP/CVP Export Service Areas.

Commensurate with the EC decrease in exported waters, an improvement in lower San Joaquin River average EC levels would be expected since EC in the lower San Joaquin River is, in part, related to irrigation water deliveries from the Delta. While the magnitude of this expected lower San Joaquin River improvement in EC is difficult to predict, the relative decrease in overall loading of EC-elevating constituents to the Export Service Areas would likely alleviate or lessen any expected increase in EC at Vernalis related to decreased annual average San Joaquin River flows (see EC impact discussion under No Action Alternative LLT).

The export area of the Delta is listed on the state's CWA Section 303(d) list as impaired due to elevated EC. Alternative 9 LLT would result in lower long-term average EC levels relative to existing conditions and the No Action Alternative NT and LLT and, thus, would not contribute to additional beneficial use impairment related to elevated EC in the SWP/CVP Export Service Areas waters.

CEQA Conclusion: Relative to existing conditions, Alternative 9 LLT would not result in any substantial increases in long-term average EC levels upstream of the Delta or in the SWP/CVP Export Service Areas. In the Delta region, Alternative 9 LLT would result in a <1% increase in the frequency with which Bay-Delta WQCP EC objectives are exceeded in the San Joaquin River at San Andreas Landing (interior Delta) for the entire period modeled (1976-1991). Further, average EC levels at San Andreas Landing would increase by 16% for the entire period modeled and 33% during the drought period modeled. Because EC is not bioaccumulative, the increases in long-term average EC levels would not directly cause bioaccumulative problems in aquatic life or humans. The interior Delta is not Clean Water Act section 303(d) listed for elevated EC, and other portions of the Delta that are section 303(d) listed would not have increased long-term average EC levels. The increases in long-term and drought period average EC levels and increased frequency of exceedance of EC objectives that would occur in the San Joaquin River at San Andreas would potentially contribute to adverse effects on the agricultural beneficial uses in the interior Delta. This impact is considered to be potentially significant.

Further, relative to existing conditions, Alternative 9 LLT would result in substantial increases in long-term average EC during the months of October through May in Suisun Marsh, such that EC levels would be double or triple that occurring under existing conditions. The increases in long-term average EC levels that would occur in Suisun Marsh could further degrade existing EC levels and thus contribute additionally to adverse effects on the fish and wildlife beneficial uses. Because EC is not bioaccumulative, the increases in long-term average EC levels would not directly cause bioaccumulative problems in wildlife. Suisun Marsh is Clean Water Act section 303(d) listed for elevated EC and the increases in long-term average EC that would occur in the marsh could make beneficial use impairment measurably worse. This impact is considered to be potentially significant.

While Mitigation Measure WQ-11 may reduce these impacts, the feasibility and effectiveness of this mitigation measures is uncertain. Therefore, the available mitigation would not necessarily reduce the impact to a level that would be less than significant.

Mitigation Measure WQ-11: Reduce, avoid, and compensate for reduced water quality conditions

Please see Mitigation Measure WQ-11 under Impact WQ-11 in the discussion of Alternative 1A.

Impact WQ-12: Effects on electrical conductivity resulting from implementation of CM2–CM22

Effects of CM2–CM22 on EC under Alternative 9 LLT are the same as those discussed for Alternative 1A LLT. There would be no adverse effect. Under CEQA, this impact would be considered less than significant.No mitigation is required.

Impact WQ-13: Effects on mercury concentrations resulting from facilities operations and maintenance (CM1)

[*Note to Lead Agencies: This assessment is in preparation*].

Impact WQ-14: Effects on mercury concentrations resulting from implementation of CM2–CM22

[*Note to Lead Agencies: This assessment is in preparation*].

Impact WQ-15: Effects on nitrate concentrations resulting from facilities operations and maintenance (CM1)

Upstream of the Delta

For the same reasons stated for the No Action Alternative LLT, Alternative 9 LLT would have negligible, if any, impact on nitrate concentrations in the rivers and reservoirs upstream of the Delta in the Sacramento River watershed relative to existing conditions and the No Action Alternative NT and LLT.

Under Alternative 9 LLT, modeling indicates that long-term annual average flows on the San Joaquin River would decrease by an estimated 6%, relative to existing conditions, 5% relative to No Action NT, and would remain virtually the same relative to No Action LLT (crossreference to Modeling Data Appendix, CALSIM Flow Data for Vernalis). Given these relatively small decreases in flows and the weak correlation between nitrate and flows in the San Joaquin River (see Nitrate Appendix J Figure 2), it is expected that nitrate concentrations in the San Joaquin River will be minimally affected, if at all, by changes in flow rates under Alternative 9 LLT.

Any negligible changes in nitrate-N concentrations that may occur in the water bodies of the affected environment located upstream of the Delta would not be of frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the quality of these water bodies, with regards to nitrate.

Delta

Results of the mixing calculations indicate that under Alternative 9 LLT, relative to existing conditions, No Action NT, and No Action LLT, nitrate concentrations throughout the Delta are anticipated to remain low (<1.4 mg/L-N) relative to adopted objectives (Nitrate Appendix J Table 31 and 32). Long-term average nitrate concentrations are anticipated to increase at most locations in the Delta. The increase would be greatest at Franks Tract, Old River at Rock Slough, and Contra

Costa Pumping Plant #1 (all >100% increase). Long-term average concentrations were estimated to increase to 0.96, 1.32 and 1.38 mg/L-N for Franks Tract, Old River at Rock Slough, and Contra Costa Pumping Plant#1, respectively, due primarily to increased San Joaquin River water percentage at these locations (see Fingerprinting Appendix D). Although changes at specific Delta locations and for specific months may be substantial on a relative basis, the absolute concentration of nitrate in Delta waters would remain low (<1.4 mg/L-N) in relation to the drinking water MCL of 10 mg/L-N, as well as all other thresholds identified in Table XX. No additional exceedances of the MCL are anticipated at any location (Nitrate Appendix J Table 31). On a monthly average basis and on a long term annual average basis, for all modeled years and for the drought period (1987-1991) only, use of assimilative capacity available under existing conditions, No Action NT, and No Action LLT, relative to the drinking water MCL of 10 mg/L-N, was up to approximately 13% at Old River at Rock Slough and Contra Costa Pumping Plant #1, and averaged approximately 9% on a long-term average basis(Nitrate Appendix J Table 33). Similarly, the use of available assimilative capacity at Franks Tract was up to approximately 10%, and averaged approximately 6% over the long term. The concentrations estimated for these locations would not increase the likelihood of exceeding the 10 mg/L-N MCL, nor would they increase the risk for adverse effects to beneficial uses. At all other locations, use of assimilative capacity was negligible (<5%) (Nitrate Appendix J Table 33).

Nitrate concentrations will likely be higher than the modeling results indicate in certain locations, including: (1) in the Sacramento River between Freeport and Mallard Island and other areas in the Delta downstream of Freeport that are influenced by Sacramento River water, the increase becoming greater with increasing distance downstream, due to conversion of ammonia from the SRWTP discharge at Freeport (under existing conditions and No Action Alternative NT only, since upgrades to SRWTP that substantially reduce ammonia concentrations in the Sacramento River downstream of Freeport are assumed in the LLT; see the Ammonia section of this chapter for further discussion); (2) immediately downstream of wastewater treatment plants that practice nitrification, but not denitrification (e.g., City of Rio Vista Beach WWTF, Town of Discovery Bay WWTF, City of Stockton RWCF).

The effect of (1) (above) is expected to be small, on the order of 1 mg/L nitrate as N or less in the existing conditions and No Action Alternative NT. This is because the existing increase appears to be from approximately 0.1 mg/L-N to approximately 0.4-0.5 mg/L-N over this reach, due to approximately a 1:1 conversion of ammonia-N to nitrate-N (CVWQCB 2010:32). Because this nitrate is assumed not to be generated under Alternative 9 LLT, average concentrations would be expected to decrease under Alternative 9 LLT in this reach of the Sacramento River relative to existing conditions and the No Action Alternative NT. Regarding number (2) (above), for all such facilities in the Delta, the Regional Water Boards have issued NPDES permits that allow discharge of wastewater containing nitrate into the Delta, and under these permits, the State has determined that no beneficial uses are adversely affected by the discharge, and that the discharger's use of available assimilative capacity of the water body is acceptable. When dilution is necessary in order for the discharge to be in compliance with the Basin Plans (which incorporate the 10 mg/L-N MCL by reference), not all of the assimilative capacity of the receiving water is granted to the discharger. Thus, limited decreases in flows are not anticipated to result in systemic exceedances of the MCLs by these POTWs. Furthermore, NPDES permits are renewed on a 5-year basis, and thus, if under changes in flows, dilution was no longer sufficient to maintain nitrate below the MCL in the receiving water, the NPDES permit renewal process would address such cases.

Therefore, any increases in nitrate-N concentrations that may occur at certain locations within the Delta would not be of frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the water quality at these locations, with regards to nitrate.

SWP/CVP Export Service Areas

Assessment of effects of nitrate in the SWP and CVP Export Service Areas is based on effects on nitrate-N at the Banks and Jones pumping plants.

Results of the mixing calculations indicate that under Alternative 9 LLT, relative to existing conditions, No Action NT, and No Action LLT, nitrate concentrations at Banks and Jones pumping plants are anticipated to decrease on a long-term average annual basis (Nitrate Appendix J Table 31 and 32). No additional exceedances of the MCL are anticipated (Nitrate Appendix J Table 31). On a monthly average basis and on a long term annual average basis, for all modeled years and for the drought period (1987-1991) only, use of assimilative capacity available under existing conditions and No Action NT, relative to the 10 mg/L-N MCL, was negligible for both Banks and Jones pumping plants (Nitrate Appendix J Table 33).

Therefore, implementation of this alternative is not expected to result in adverse effects to beneficial uses or substantially degrade the quality of exported water, with regards to nitrate.

CEQA Conclusion: This alternative is not expected to cause additional exceedance of applicable water quality objectives/criteria by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. No long-term water quality degradation is expected to occur such that exceedance of criteria is more likely or such that there is an increased risk of adverse impacts to beneficial uses. Nitrate is not 303(d) listed within the affected environment and thus any increases than may occur in some areas and months would not make any existing nitrate-related impairment measurably worse because no such impairments currently exist. Because nitrate is not bioaccumulative, increases that may occur in some areas and months would not bioaccumulate to greater levels in aquatic organisms that would, in turn, pose substantial health risks to fish, wildlife, or humans. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-16: Effects on nitrate concentrations resulting from implementation of CM2–23

Effects of CM2–23 on nitrate under Alternative 9 LLT are the same as those discussed for Alternative 1A LLT. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-17: Effects on dissolved organic carbon concentrations resulting from facilities operations and maintenance (CM1)

Upstream of the Delta

Under Alternative 9 LLT, there would be no substantial change to the sources of DOC within the watersheds upstream of the Delta. Moreover, long-term average flow and DOC levels in the Sacramento River at Hood and San Joaquin River at Vernalis are poorly correlated. Thus changes in system operations and resulting reservoir storage levels and river flows would not be expected to cause a substantial long-term change in DOC concentrations in the water bodies upstream of the Delta. Any negligible changes in DOC levels in water bodies upstream of the Delta under Alternative 9 LLT, relative to existing conditions and the No Action Alternative NT and LLT, would not be of sufficient frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the quality of these water bodies, with regards to DOC.

Delta

Under Alternative 9 LLT, the geographic extent of effects pertaining to long-term average DOC concentrations in the Delta would be similar to that previously described for Alternative 1A LLT, although the magnitude of predicted long-term increase and relative frequency of concentration threshold exceedances would be substantially greater. Modeled effects would be greatest at Franks Tract, Rock Slough, and Contra Costa PP No. 1., where for the 16-year hydrologic period and the modeled drought period, long-term average concentration increases ranging from 0.6-1.0 mg/L would be predicted (≤28% net increase), resulting in long-term average DOC concentrations greater than 4 mg/L at Rock Slough and Contra Costa PP No. 1 (Appendix 8K, DOC Table 10). Increases in long-term average concentrations would correspond to more frequent concentration threshold exceedances, with the greatest change occurring at Rock Slough and Contra Costa PP No. 1 locations. For Rock Slough, long-term average DOC concentrations exceeding 3 mg/L would increase from 52% under existing conditions to 99% under the Alternative 9 LLT (an increase from 47% to 100% for the drought period), and concentrations exceeding 4 mg/L would increase from 30% to 44% (32% to 67% for the drought period). For Contra Costa PP No. 1, long-term average DOC concentrations exceeding 3 mg/L would increase from 52% under existing conditions to 100% under Alternative 9 LLT (45% to 100% for the drought period), and concentrations exceeding 4 mg/L would increase from 32% to 45% (35% to 65% for the drought period). Relative change in frequency of threshold exceedance for other assessment locations would be similar or less.

In comparison, Alternative 9 LLT relative to the No Action Alternative NT and No Action Alternative LLT would generally result in a similar magnitude of change to that discussed for the comparison to existing conditions. Maximum increases of 0.7-1.0 mg/L DOC (i.e., ≤29%) would be predicted at Franks Tract, Rock Slough, and Contra Costa PP No. 1 relative to No Action Alternative NT, while maximum increases at these locations would be slightly less (i.e., between 0.6-0.9 mg/L, ≤24%) when compared to No Action Alternative LLT (Appendix 8K, DOC Table 10). Threshold concentration exceedance frequency trends would also be similar to that discussed for the existing condition comparison, with exception to the predicted 4 mg/L exceedance frequency at Buckley Cove. In comparison to the No Action Alternative NT, the frequency which long-term average DOC concentrations exceeded 4 mg/L at Buckley Cove would increase from 23% to 39% (37% to 50% for the modeled drought period), with slightly smaller increases when comparing to No Action Alternative LLT.

The increases in long-term average DOC concentrations estimated to occur at Franks Tract, Rock Slough, and Contra Costa PP No. 1 are considered substantial and could potentially trigger significant changes in drinking water treatment plant design or operations. In particular, assessment locations at Rock Slough and Contra Costa PP No. 1 represent municipal intakes servicing existing drinking water treatment plants. Under Alternative 9, drinking water treatment plants obtaining water from these interior Delta locations would likely need to upgrade existing treatment systems in order to achieve EPA Stage 1 Disinfectants and Disinfection Byproduct Rule action thresholds. While treatment technologies sufficient to achieve the necessary DOC removals exist, implementation of such technologies would likely require substantial investment in new or modified infrastructure.

Relative to existing, No Action Alternative NT, and No Action Alternative LLT conditions, Alternative 9 LLT would lead to predicted improvements in long-term average DOC concentrations at Barker

Slough and Staten Island, as well Banks and Jones pumping plants. Predicted long-term average DOC concentrations at Barker Slough and Staten Island would decrease 0.1-0.2 mg/L, while long-term average DOC concentrations at Banks and Jones would decrease as much as 1.5-1.8 mg/L, depending on baseline conditions comparison and modeling period.

SWP/CVP Export Service Areas

Under Alternative 9 LLT, modeled long-term average DOC concentrations would decrease at Banks and Jones pumping plants for both the modeled 16-year hydrologic period and the modeled drought period. Modeled decreases would generally be similar between existing conditions, No Action Alternative NT, and No Action Alternative LLT. Relative to existing conditions, long-term average DOC concentrations at Banks would be predicted to decrease by 1.5 mg/L (1.8 mg/L during drought period) (Appendix 8K, DOC Table 10Table). At Jones, long-term average DOC concentrations would be predicted to decrease by 1.5 mg/L (1.7 mg/L during drought period). Such substantial improvement in long-term average DOC concentrations would include fewer exceedances of concentration thresholds. At both Banks and Jones, average DOC concentrations exceeding the 2 mg/L concentration threshold would decrease from 100% under existing conditions, No Action Alternative NT and No Action Alternative LLT to 39% under Alternative 9 (100% to 32% during the drought period), while concentrations exceeding 4 mg/L would nearly be eliminated (i.e., ≤10% exceedance frequency). Such modeled improvement would correspond to substantial improvement in Export Service Areas water quality, respective to DOC.

Similar to the discussion pertaining to the No Action Alternative LLT, maintenance of SWP and CVP facilities under Alternative 9 LLT would not be expected to create new sources of DOC or contribute towards a substantial change in existing sources of DOC in the affected area. Maintenance activities would not be expected to cause any substantial change in long-term average DOC concentrations such that MUN beneficial uses, or any other beneficial use, would be adversely affected.

CEQA Conclusion: Relative to existing conditions, Alternative 9 LLT operation and maintenance would not result in any substantial change in long-term average DOC concentration upstream of the Delta. Furthermore, under Alternative 9 LLT, water exported from the Delta to the SWP/CVP service area would be substantially improved relative to DOC. DOC is not bioaccumulative, therefore change in long-term average DOC concentrations would not directly cause bioaccumulative problems in aquatic life or humans. Additionally, DOC is not a constituent related to any 303(d) listings. Nevertheless, new and modified conveyance facilities proposed under Alternative 9 LLT would result in a substantial increase in long-term average DOC concentrations (i.e., 0.6-1.0 mg/L, equivalent to ≤28% relative increase) at Franks Tract, Rock Slough, and Contra Costa PP No.1. In particular, under Alternative 9 LLT, model predicted long-term average DOC concentrations would be greater than 4 mg/L at Rock Slough and Contra Costa PP No. 1 with commensurate substantial increases in the frequency with which average DOC concentrations exceed 2, 3, and 4 mg/L levels. Drinking water treatment plants obtaining water from these interior Delta locations would likely need to upgrade existing treatment systems in order to achieve EPA Stage 1 Disinfectants and Disinfection Byproduct Rule action thresholds. Therefore, such a magnitude change in long-term average DOC concentrations would represent a substantially increased risk for adverse effects on existing MUN beneficial uses at Rock Slough and Contra Costa PP No. 1 should such treatment upgrades not be undertaken. The impact is considered significant and mitigation is required. While Mitigation Measure WQ-17 is available to partially reduce this impact of DOC, the feasibility and effectiveness of this mitigation measures is uncertain and therefore it is not known if its implementation would reduce the identified impact to a level that would be less than significant.

Mitigation Measure WQ-17:

To reduce the effect of CM1 operations on increased DOC concentrations specifically predicted to occur at municipal water purveyors obtaining raw source water through south Delta intakes at Rock Slough and those associated with Contra Costa PP No. 1, DWR and Reclamation shall coordinate with the purveyors to identify the means to compensate for increases in long-term average DOC concentrations. DWR and Reclamation shall implement any combination of measures sufficient to maintaining DBP concentrations at existing levels (i.e., as system-wide running annual average) in treated drinking water of affected water purveyors. Such actions may include, but not be limited to, providing monetary compensation sufficient to: 1) upgrade and maintain adequate drinking water treatment systems, 2) develop or obtain replacement surface water supplies from other water rights holders, 3) develop replacement groundwater supplies, or 4) physically route a portion of the water diverted from the Sacramento River through the associated new conveyance pipelines/tunnel to affected purveyors.

Impact WQ-18: Effects on DOC concentrations resulting from implementation of CM2-CM22

Conservation components under Alternative 9 would be similar to those under Alternative 1A, but with changes in the south Delta to accommodate the modified corridors. Therefore, effects on DOC resulting from the implementation of CM2-CM22 would be similar to that previously discussed for Alternative 1A LLT. In summary, conservation measures CM4CM7 and CM10 could contribute substantial amounts of DOC to raw drinking water supplies , largely depending on final design and operational criteria for the related wetland and riparian habitat restoration activities. Substantially increased long-term average DOC in raw water supplies could lead to a need for treatment plant upgrades in order to appropriately manage DBP formation in treated drinking water. This potential for future DOC increases would lead to substantially greater associated risk of long-term adverse effects on the MUN beneficial use.

CEQA Conclusion: Effects of CM4-CM7 and CM10 on DOC under Alternative 9 LLT are similar to those discussed for Alternative 1A LLT. Similar to the discussion for Alternative 1A, this impact is considered to be significant. Mitigation is required. It is uncertain whether implementation of Mitigation Measure WQ-18 would reduce identified impacts to a less than significant level. Hence, this impact could remain significant after mitigation.

Mitigation Measure WQ-18: Design wetland and riparian habitat features to minimize effects on municipal intakes

Please see Mitigation Measure WQ-18 under Impact WQ-18 in the discussion of Alternative 1A.

Impact WQ-19: Effects on pathogens resulting from facilities operations and maintenance

Effects of CM1 on pathogens under Alternative 9 are the same as those discussed for Alternative 1A LLT. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-20: Effects on pathogens resulting from implementation of CM2–CM22

Effects of CM2–CM22on pathogens under Alternative 9 are the same as those discussed for Alternative 1A LLT. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-22: Effects on pesticide concentrations resulting from facilities operations and maintenance (CM1)

Upstream of the Delta

For the same reasons stated for the No Action Alternative LLT, under Alternative 9 LLT no specific operations or maintenance activity of the SWP or CVP would substantially drive a change in pesticide use, and thus pesticide sources would remain unaffected upstream of the Delta. Nevertheless, changes in the timing and magnitude of reservoir releases could have an effect on available dilution capacity along river segments such as the Sacramento, Feather, American, and San Joaquin Rivers.

Under Alternative 9 LLT, winter (November –March) and summer (April – October) season average flow rates on the Sacramento River at Freeport, American River at Nimbus, Feather River at Thermalito and the San Joaquin River at Vernalis would change. Relative to existing condition, No Action Alternative NT and No Action Alternative LLT, seasonal average flow rates on the Sacramento would decrease no more than 5% during the summer and 3% during the winter relative to existing conditions (Appendix 8L, Seasonal average flows Tables 1-4). On the Feather River, average flow rates would increase by as much as 10% during the summer, but would decrease by as much as 5% in the winter. American River average flow rates would decrease by as much as 17% in the summer but would increase by as much as 10% in the winter. Seasonal average flow rates on the San Joaquin River would decrease by as much as 12% in the summer, but increase by as much as 3% in the winter. For the same reasons stated for the No Action Alternative LLT, decreased seasonal average flow of ≤17% is not considered to be of sufficient magnitude to substantially increase pesticide concentrations or alter the long-term risk of pesticide-related toxicity to aquatic life, nor adversely affect other beneficial uses of water bodies upstream of the Delta.

Delta

Sources of diuron, OP and pyrethroid insecticides to the Plan Area include direct input of surface runoff from in-Delta agriculture and Delta urbanized areas as well inputs from rivers upstream of the Delta. Similar to Upstream of the Delta, CVP/SWP operations would not affect these sources.

Under Alternative 9 LLT, the distribution and mixing of Delta source waters would change. Percent change in monthly average source water fraction were evaluated for the modeled 16-year (1976-1991) hydrologic period and a representative drought period (1987-1991), with special attention given to changes in San Joaquin River, Sacramento River and Delta Agriculture sources water fractions. Relative to existing conditions, under Alternative 9 LLT modeled San Joaquin River fractions would increase greater than 10% at Franks Tract, Rock Slough, Contra Costa PP No. 1, and the San Joaquin River at Antioch (Appendix 8D, Source Water Fingerprinting). At Antioch, San Joaquin River source water fractions would increase by 12-15% from October through May (11-14% from November through April for the modeled drought period). While this change at Antioch is not considered substantial, changes in San Joaquin River source water fraction in the Delta interior would be considerable. At Franks Tract, San Joaquin River source water fractions would increase between 25-57% for the entire calendar year of January through December (11-52% for October through July of the modeled drought period). Changes at Rock Slough and Contra Costa PP No. 1 would be very similar, where modeled San Joaquin River source water fractions would increase from 35-80% (25-78% for the modeled drought period) for the entire calendar year of January through December. In addition, Sacramento River fractions would increase greater than 10% at Staten Island and Buckley Cove (not including Banks and Jones). At Staten Island, Sacramento River fractions would increase by 16% in April and 20% in May (13-15% from February through April of the modeled drought period). These changes at Staten Island are not considered substantial. At Buckley Cove, however, Sacramento source water fraction would increase between 36-72% (46-73% for the drought period) for the entire calendar year of January through December. Although a considerable change, this change in source water fraction at Buckley Cove would balance through a nearly equivalent decrease in San Joaquin River water. Delta agricultural fractions would not increase greater than 8% at any assessment location.

Relative to existing conditions, increases in San Joaquin River source water fraction at Franks Tract, Rock Slough, and Contra Costa PP NO. 1 would primarily balance through decreases in Sacramento River water, and as a result the San Joaquin River would account for greater than 50% of the total source water volume at Franks Tract between October and June (>50% for November and December during the modeled drought period), and would be greater than 50%, and as much as 86% during for the entire calendar year at Rock Slough and Contra Costa PP No. 1 (greater than 50% and as high as 80% for October through June of the modeled drought period). While the source water and potential pesticide related toxicity co-occurrence predictions do not mean adverse effect would occur, such considerable modeled increases in winter and early summer source water fraction at Franks Tract and winter and summer source water fractions at Rock Slough and Contra Costa PP No. 1 could substantially alter the long-term risk of pesticide-related toxicity to aquatic life, given the apparent greater incidence of pesticides in the San Joaquin River.

When compared to No Action Alternative NT and No Action Alternative LLT, changes in source water fractions would be similar in season, geographic extent, and magnitude to those discussed for existing conditions (Appendix 8D, Source Water Fingerprinting). Relative to No Action Alternative NT and No Action Alternative LLT the similar magnitude increase in San Joaquin River source water fraction at Franks Tract, Rock Slough, and Contra Costa PP No. 1 would be considered substantial and could substantially increase the long-term risk of pesticide-related toxicity to aquatic life.

These predicted adverse effects on pesticides relative to existing conditions, No Action Alternative NT, and No Action Alternative LLT fundamentally assume that the present pattern of pesticide incidence in surface water will occur at similar levels into the future. In reality, however, the makeup and character of the pesticide use market in the late long-term (i.e., the year 2060) will not be exactly as it istoday. Current use of chlorpyrifos and diazinon is on the decline with their replacement by pyrethroids on the rise, yet in this assessment it is the apparent greater incidence of diazinon and chlorpyrifos on the San Joaquin River that serves as the basis for concluding that substantially increased San Joaquin River source water fraction would correspond to an increased risk of pesticide-related toxicity to aquatic life. By 2060, however, alternatives pesticides, such as neonicitinoids and biologicals, will likely be a more substantial contributing part of the existing mix of pesticides, and perhaps more prominent. The trend in the development of future-use pesticides is towards reduced risk pesticides, including more biopesticides, with greater targeted specificity, fewer residues, and lower overall non-target toxicity. By 2060 existing chlorpyrifos and diazinon TMDLs for the Sacramento and San Joaquin Rivers will have been in effect for more than 50 years. Moreover, it is reasonable to expect that CWA section 303(d) listings and future additional listings will have developed TMDLs by 2060. To the extent these existing and future TMDL's address current and future-use pesticides, a greater degree of pesticide related source control can be anticipated. Nevertheless, forecasting whether these various efforts will ultimately be successful at resolving current pesticide related impairments requires considerable speculation. While the fundamental assumptions that have guided this assessment of pesticides may be somewhat altered by 2060, these assumptions are informed by actual studies and monitoring data collected from the recent past and, therefore, judging project alternative effects in the future remain most accurate through use of these informed assumptions rather than based on assumptions founded upon future speculative conditions.

SWP/CVP Export Service Areas

Assessment of effects in SWP/CVP Export Service Areas is based on effects seen in the Plan Area at the Banks and Jones pumping plants. Under Alternative 9 LLT, Sacramento River source water fractions would increase at both Banks and Jones pumping plants relative to existing conditions, No Action Alternative NT and No Action Alternative LLT (Appendix 8D, Source Water Fingerprinting). At Banks pumping plant, Sacramento source water fractions would generally increase from 12-38% for February through June (12-37% for February through June of the modeled drought period) and at Jones pumping plant Sacramento source water fractions would generally increase from 7-54% for the entire calendar year (14-69% for September through June of the modeled drought period). These increases in Sacramento source water fraction would primarily balance through equivalent decreases in San Joaquin River water. Based on the general observation that San Joaquin River, in comparison to the Sacramento River, is a greater contributor of OP insecticides in terms of greater frequency of incidence and presence at concentrations exceeding water quality benchmarks, modeled increases in Sacramento River fraction at Banks and Jones would generally represent an improvement in export water quality respective to pesticides.

CEQA Conclusion: Relative to existing conditions, the Alternative 9 LLT would not result in any substantial change in long-term average pesticide concentration or result in substantial increase in the anticipated frequency with which long-term average pesticide concentrations would exceed aquatic life toxicity thresholds or other beneficial use effect thresholds upstream of the Delta or the SWP/CVP service area. Numerous pesticides are currently used throughout the affected environment, and while some of these pesticides may be bioaccumulative, those present-use pesticides for which there is sufficient evidence for their presence in waters affected by SWP and CVP operations (i.e., diazinon, chlorpyrifos, diuron, and pyrethroids) are not considered bioaccumulative, and thus changes in their concentrations would not directly cause bioaccumulative problems in aquatic life or humans. Furthermore, while there are numerous 303(d) listings throughout the affected environment that name pesticides as the cause for beneficial use impairment, the modeled changes in upstream river flows and Delta source water fractions would not be expected to make any of these beneficial use impairments measurably worse, with principal exception to locations in the Delta that would receive a substantially greater fraction San Joaquin River water under Alternative 9. Long-term average San Joaquin River source water fractions at Franks Tract, Rock Slough and Contra Costa PP No. 1 locations would change considerably for the calendar year such that the long-term risk of pesticide-related toxicity to aquatic life could substantially increase. Additionally, the potential for increased incidence of pesticide related toxicity could include pesticides such as chlorpyrifos and diazinon for which existing 303(d) listings exist for the Delta, and thus existing beneficial use impairment could be made discernibly worse. The impact is considered to be significant and unavoidable. There is no feasible mitigation available to reduce the effect of this significant impact.

Impact WQ-22: Effects on pesticide concentrations resulting from implementation of CM2–CM22

Conservation components under Alternative 9 would be similar to those under Alternative 1A, but with changes in the south Delta to accommodate the modified corridors. Effects on pesticides resulting from the implementation of CM2–CM22would be similar to that previously discussed for Alternative 1A LLT. In summary, CM13 proposes the use of herbicides to control invasive aquatic vegetation around habitat restoration sites. Herbicides directly applied to water could include adverse effects on non-target aquatic life, such as aquatic invertebrates and beneficial aquatic plants. As such, aquatic life toxicity objectives could be exceeded with sufficient frequency and magnitude such that beneficial uses would be impacted.

***CEQA Conclusion*:** Effects of CM2–CM22on pesticides under Alternative 9 LLT are the similar as those discussed for Alternative 1A LLT. Potential environmental effects related only to CM13 are considered to be significant. Mitigation is required. While Mitigation Measure WQ-22 is available to partially reduce this impact of pesticides, no feasible mitigation is available that would reduce it to a level that would be less than significant.

Mitigation Measure WQ-22: Implement least toxic integrated pest management strategies

Please see Mitigation Measure WQ-22 under Impact WQ-22 in the discussion of Alternative 1A.

Impact WQ-23: Effects on phosphorus concentrations resulting from facilities operations and maintenance (CM1)

Effects of water facilities and operations (CM1) on phosphorus levels in water bodies of the affected environment under Alternative 3 LLT would be very similar (i.e., nearly the same) as those discussed for Alternative 1A LLT. Consequently, the environmental consequences to phosphorus levels discussed in detail for Alternative 1A LLT also adequately represent the effects under Alternative 3 LLT. Based on this finding, this impact is considered to be less than significant. No mitigation is required.

Impact WQ-24: Effects on phosphorus concentrations resulting from implementation of CM2–CM22

Effects of CM2–23 on phosphorus levels in water bodies of the affected environment under Alternative 9 LLT would be very similar (i.e., nearly the same) as those discussed for Alternative 1A LLT. Consequently, the environmental consequences to phosphorus levels from implementing CM2-CM22 discussed in detail for Alternative 1A LLT also adequately represent the effects of these same actions under Alternative 9 LLT. Based on this finding, this impact is considered to be less than significant. No mitigation is required.

Impact WQ-25: Effects on selenium concentrations resulting from facilities operations and maintenance (CM1)

[*Note to Lead Agencies: This assessment is in preparation*].

Impact WQ-26: Effects on selenium concentrations resulting from implementation of CM2–CM22

[*Note to Lead Agencies: This assessment is in preparation*].

Impact WQ-28: Effects on trace metal concentrations resulting from facilities operations and maintenance (CM1)

Upstream of the Delta

For the same reasons stated for the No Action Alternative LLT, Alternative 9 LLT would result in negligible, and likely immeasurable, increases in trace metal concentrations in the rivers and reservoirs upstream of the Delta, relative to existing conditions, No Action NT and No Action LLT. Effects due to the operation and maintenance of the conveyance facilities are expected to be immeasurable, on an annual and long-term average basis. As such, the Alternative 9 would not be expected to substantially increase the frequency with which applicable Basin Plan objectives or CTR criteria would be exceeded in water bodies of the affected environment located upstream of the Delta or substantially degrade the quality of these water bodies, with regard to trace metals.

Delta

For the same reasons stated for the No Action Alternative LLT, Alternative 9 LLT would not result in substantial increases in trace metal concentrations in the Delta relative to existing conditions, No Action NT, and No Action LLT. However, substantial changes in source water fraction would occur in the south Delta (see Appendix D [editor: reference to Fingerprinting Appendix]). Throughout much of the south Delta, San Joaquin River water would replace Sacramento River water, with the future trace metals profile largely reflecting that of the San Joaquin River. As discussed for the No Action Alternative, trace metal concentration profiles between the San Joaquin and Sacramento Rivers are very similar and currently meet Basin Plan objectives and CTR criteria. While the change in trace metal concentrations in the south Delta would likely be measurable, Alternative 9 would not be expected to substantially increase the frequency with which applicable Basin Plan objectives or CTR criteria would be exceeded in the Delta or substantially degrade the quality of Delta waters with regard to trace metals.

SWP/CVP Export Service Areas

For the same reasons stated for the No Action Alternative LLT, Alternative 9 LLT would not result in substantial increases in trace metal concentrations in the water exported from the Delta or diverted from the Sacramento River through the proposed conveyance facilities. As such, there is not expected to be substantial changes in trace metal concentrations in the SWP/CVP export service area waters under Alternative 9, relative to existing conditions, No Action NT, and No Action LLT. As such, Alternative 9 would not be expected to substantially increase the frequency with which applicable Basin Plan objectives or CTR criteria would be exceeded in the water bodies of the affected environment in the SWP and CVP Service Area or substantially degrade the quality of these water bodies, with regard to trace metals.

***CEQA Conclusion*:** There would be no substantial long-term increase in trace metal concentrations in the rivers and reservoirs upstream of the Delta, in the Delta Region, or the SWP/CVP export service area waters under Alternative 9 relative to existing conditions. As such, this alternative is not expected to cause additional exceedance of applicable water quality objectives by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. Because trace metal concentrations are not expected to increase substantially, no long-term water quality degradation for trace metals is expected to occur and, thus, no adverse effects to beneficial uses would occur. Furthermore, any negligible changes in long-term trace metal concentrations that may occur in water bodies of the affected environment would not be expected to make any existing beneficial use impairments measurably worse. The trace metals discussed in this assessment are not considered bioaccumulative, and thus would not directly cause bioaccumulative problems in aquatic life or humans. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-28: Effects on trace metal concentrations resulting from implementation of CM2–CM22

Conservation components under Alternative 9 would be similar to those under Alternative 1A, but with changes in the south Delta to accommodate the modified corridors. Effects on trace metals resulting from the implementation of conservation measures 2-22 would be similar to that previously discussed for Alternative 1A. As they pertain to trace metals, implementation of CM2-CM22 would not be expected to adversely affect beneficial uses of the affected environment or substantially degrade water quality with respect to trace metals.

CEQA Conclusion: Implementation of CM2-CM22 under Alternative 9 would not cause substantial long-term increase in trace metal concentrations in the rivers and reservoirs upstream of the Delta, in the Delta Region, or the SWP/CVP export service area. As such, this alternative is not expected to cause additional exceedance of applicable water quality objectives by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. Because trace metal concentrations are not expected to increase substantially, no long-term water quality degradation for trace metals is expected to occur and, thus, no adverse effects to beneficial uses would occur. Furthermore, any negligible changes in long-term trace metal concentrations that may occur throughout the affected environment would not be expected to make any existing beneficial use impairments measurably worse. The trace metals discussed in this assessment are not considered bioaccumulative, and thus would not directly cause bioaccumulative problems in aquatic life or humans. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-29: Effects on TSS and turbidity resulting from facilities operations and maintenance (CM1)

Effects of CM1 on TSS and turbidity under Alternative 9 are the same as those discussed for Alternative 1A LLT. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-30: Effects on TSS and turbidity resulting from implementation of CM2–CM22

Effects of CM2–CM22on TSS and turbidity under Alternative 9 are the same as those discussed for Alternative 1A LLT. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-31: Water quality impacts resulting from construction-related activities for CM1-CM22 implementation

The construction activities necessary to implement new conveyance features for CM1 under Alternative 9 LLT would involve substantially different locations and types of construction activity to those discussed for Alternative 1A. In particular, the construction of permanent operable gates, locks, levee and channel improvements, and pumping stations within the Delta would involve considerable in-channel dredging and facility construction activity. However, construction techniques for many features of the conveyance system within the Delta would be similar. The remainder of the facilities constructed under Alternative 9, including conservation measures CM2–CM22, would be very similar to, or the same as, those to be constructed for Alternative 1A.

The types of potential construction-related materials used, constituent discharges, and related water quality effects associated with implementation of conservation measures CM1 under Alternative 9 would be similar to the effects discussed for Alternative 1A LLT, and the effects anticipated with implementation of CM2–CM22 would be essentially identical. Given the substantial differences in the conveyance features under CM1, there could be differences in the location, magnitude, duration, and frequency of construction activities and related water quality effects. In particular, relative to the existing conditions and No Action Alternative conditions, the extensive dredging and channel improvements under Alternative 9 would result in the potential for in-water turbidity and sediment resuspension. Nevertheless, the construction of CM1 with the environmental commitments would result in the potential water quality effects being largely avoided and minimized. The specific environmental commitments that would be implemented under Alternative 9 would be similar to those described for Alternative 1A Consequently, relative to existing conditions, Alternative 9 LLT would not be expected to cause exceedance of applicable water quality objectives/criteria or substantial degradation with respect to constituents of concern, and thus would not adversely affect any beneficial uses upstream of the Delta, in the Delta, or in the SWP and CVP service area.

CEQA Conclusion: Construction-related contaminant discharges would be temporary and intermittent in nature and would involve negligible, if any, discharges of bioaccumulative or 303(d) listed constituents to water bodies of the affected environment. As such, construction activities would not contribute measurably to bioaccumulation of contaminants in organisms or humans or cause 303(d) impairments to be discernibly worse. Because environmental commitments would be implemented under Alternative 9 LLT for construction-related activities along with agency-issues permits that also contain construction requirements to protect water quality, the construction-related effects would not be expected to cause or contribute to a substantial increased frequency of exceedances of water quality objectives/criteria relative to existing conditions, or substantially degrade water quality with respect to the constituents of concern on a long-term average basis, and thus would not adversely affect any beneficial uses in water bodies upstream of the Delta, within the Delta, or in the SWP and CVP service area. Based on these findings, this impact is determined to be less than significant. No mitigation is required.

8.3.5 Cumulative Analysis

8.3.5.1 Assessment Methodology

Water quality conditions upstream of the Delta, in the Delta Region, and in the SWP/CVP export service areas of the affected environment are expected to change as a result of past, present, and reasonably foreseeable future projects, population growth, climate change, and changes in water quality regulations (e.g., completion of TMDLs, adoption of new or more restrictive criteria/objectives). Many past, present, and reasonably foreseeable future projects will contribute to the degradation of various water quality parameters, whereas others will function to improve constituent-specific water quality in certain areas. Future population growth may produce increased constituent loadings to the water bodies of the affected environment through increased urban stormwater runoff, increased POTW discharges, and changes in land uses. Climate change is anticipated to cause salinity increases in the western and southern Delta due to sea level rise.

Conversely, changes in water quality regulations generally are in a direction that results in improvements in water quality (e.g., increased monitoring and restrictions on urban stormwater runoff, completion of TMDLs to lessen or eliminate existing beneficial use impairments through improved water quality, more restrictive regulations on POTW discharges, new and/or more restrictive water quality criteria/objectives in Basin Plans).

When the effects of the BDCP alternatives on water quality are considered in connection with the potential effects of projects listed in Appendix 3D, *Ongoing Programs, Projects, and Policies included in the Cumulative Impact Assessment for the BDCP EIR/EIS* and Attachment A of Appendix 3A, *Alternatives Development Report*, the potential effects range from beneficial to potentially adverse cumulative effects on water quality, depending upon water quality constituent/parameter and location. This assessment discusses only cumulative impacts which could result, in part, from construction and implementation of the BDCP. Constituents or constituent groups which could not be affected by the BDCP are identified and addressed in the water quality Screening Analysis presented in Appendix C. The majority of the constituents assessed in the Screening Analysis have not been detected in the major source waters to the Delta, and others that have been detected have generally not exceeded water quality objectives/criteria or would not be affected by construction and implementation of the BDCP. Consequently, they are not specifically addressed in this cumulative assessment. For a discussion of cumulative effects related to water temperature, see Chapter 11, *Fisheries and Aquatic Resources.* [*Note to Lead Agencies: This section in Chapter 11 is in preparation*].

If the cumulative water quality condition (which includes implementation of the BDCP along with past, present, and reasonably foreseeable future projects, population growth, climate change, and changes in water quality regulations) for a constituent or group of constituents within a defined region of the affected environment is determined not to be adverse, then no further assessment is required. No further assessment is required because a non-adverse cumulative condition demonstrates that the BDCP alternative would not have adverse effects that are individually less than significant but that would "cumulate" or "be additive" with those of other past, present, and reasonably foreseeable projects to result in an adverse cumulative effect. In this case, because the cumulative condition would not be adverse, and thus the BDCP alternative implemented would not contribute considerably to an adverse cumulative condition, no mitigation would be triggered from this cumulative impact assessment finding. Conversely, if the cumulative condition for water quality is determined to be adverse, then further assessment is provided to determine if implementation of the BDCP alternatives would contribute considerably to that adverse cumulative condition. If a BDCP alternative's implementation would not contribute considerably to the adverse cumulative water quality condition identified, then no mitigation is required. However, if a BDCP alternative's implementation would contribute considerably to the adverse cumulative water quality condition identified, then mitigation for the BDCP alternative's contribution to the identified adverse cumulative water quality condition is proposed.

The potential for cumulative impacts on water quality is assessed for: 1) construction-related activities, 2) facilities operations and maintenance (CM1), and 3) implementation of CM2-CM22. Each BDCP alternative is assessed under each of these three impact assessment categories. Effects are specifically discussed by region of the affected environment (i.e., Upstream of the Delta, Delta Region, and SWP/CVP Export Service Areas) and by constituent or constituent groups. Individual discussions for specific action alternatives are provided only if the anticipated effects under one or more action alternatives can be meaningfully distinguished from the effects anticipated under other alternatives. If the contributions of the various action alternatives to a cumulative condition cannot be readily distinguished from one another, then a single assessment that addresses all BDCP alternatives is provided.

Cumulative Impact WQ-1. Cumulative impacts on water quality resulting from construction-related activities.

Alternatives 1A through 9

Upstream of the Delta

Construction activities upstream of the Delta would be tied to conservation measures. Conservation measures or components of these measures that would be constructed in areas upstream of the Delta would be: 1) the Yolo Bypass Fishery Enhancement (CM2) (i.e., the Fremont Weir component of the action), 2) Conservation Hatcheries (CM18) (i.e., the new hatchery facility), and 3) Urban Stormwater Treatment (CM19). Construction of CM2, CM18, and CM19 could involve site preparation and earthwork adjacent to water bodies of the affected environment. If so, their construction also would include water quality protection actions in the form of Environmental Commitments (Appendix X) and related water quality protection actions issued in agency permits required for construction and operation of facilities. Such actions would include a Stormwater Pollution Prevention Plan (SWPPP) that would minimize erosion of soils into water bodies and would minimize/eliminate the direct spilling of earthmoving equipment fuels, oils, and other construction materials into water bodies, thus minimizing any effects on water quality in adjacent water bodies. Other water quality protection actions issued in agency permits would include those in the State Water Board's NPDES Stormwater General Permit for Stormwater Discharges Associated with Construction and Land Disturbance Activities (Order No. 2009-0009-DWQ/NPDES Permit No. CAS000002), project-specific waste discharge requirements (WDRs) or CWA Section 401 water quality certification from the appropriate Central Valley Water Board, Department of Fish and Game (DFG) Streambed Alteration Agreements, and U.S. Army Corps of Engineers (USACE) CWA Section 404 dredge and fill permits. Thus, construction activities associated with Alternatives 1A through 9 would not contribute considerably to any adverse cumulative water quality condition upstream of the Delta, nor would construction-related effects make an otherwise non-adverse cumulative water quality condition adverse in this region.

Delta

For Alternatives 1A through 9, the construction of new conveyance facilities (CM1) and construction associated with implementing CM2-CM22, particularly CM2-CM10, could result in substantial adverse water quality effects associated with turbidity/TSS due to the erosion of disturbed soils and associated sedimentation entering Delta waterways or other construction-related wastes (e.g., concrete, asphalt, cleaning agents, paint, and trash). In addition, the use of heavy earthmoving equipment adjacent to Delta waterways may result in spills and leakage of oils, gasoline, diesel fuel, and related petroleum contaminants used in the fueling and operation of such construction equipment. The extensive construction activities that will be necessary to implement CM 1, 2, and 4-10 would involve a variety of land disturbances in the Delta including vegetation removal; grading and excavation of soils; establishment of roads-bridges, staging, and storage areas; in-water sediment dredging and dredge material disposal; and hauling and placement or disposal of excavated soils and dredge materials. Nevertheless, as stated in Section 8.3 (Water Quality Environmental Consequences), the implementation of construction-related Environmental Commitments (Appendix X) would reduce these potential water quality impacts to less-than-significant levels. Moreover, the cumulative condition for turbidity/TSS and petroleum contaminants in Delta waters are not expected to be adverse. This is due, in large part, to the implementation (or planned implementation) of construction-related Environmental Commitments (Appendix X) and agency permitted construction "best management practices" for construction of not only the selected BDCP alternative (including its CMs), but also other past, present, and reasonably foreseeable future projects. Because construction-related effects on all water quality constituents/parameters would be minimized through BDCP Environmental Commitments (Appendix X) and permitted construction "best management practices" in the agency-issued permits discussed above, construction activities associated with Alternatives 1A through 9 would not contribute considerably to any adverse cumulative water quality condition in the Delta, nor would construction-related effects make an otherwise non-adverse cumulative water quality condition adverse.

SWP/CVP Export Service Areas

Because construction-related activities associated with Alternatives 1A through 9 are not expected to contribute considerably to any adverse cumulative Delta water quality condition, including conditions at the Banks and Jones pumping plants, which are the primary locations of water export to the SWP/CVP Export Service Areas, the construction of these alternatives would not contribute considerably to any adverse cumulative water quality condition in water bodies located in the SWP/CVP Export Service Areas.

CEQA Conclusion: Alternatives 1A–9 involve minimal construction elements upstream of the Delta and would include implementation of construction-related Environmental Commitments (Appendix X) that would mitigate any temporary construction-related effects on water quality to less-than-significant levels. Thus their construction would not adversely affect any cumulative water quality constituent/parameter condition upstream of the Delta. Construction of conveyance facilities and CMs for the selected BDCP alternative could potentially result in temporary water quality effects on Delta turbidity/TSS levels and petroleum contaminants. However, the cumulative condition for Delta turbidity/TSS and petroleum contaminants would not be adverse for two reasons. First, implementation of construction-related Environmental Commitments (Appendix X) for the BDCP alternative to be implemented and use of related construction BMPs for other projects would reduce effects on these and other Delta water quality constituents/parameters to less-than-significant levels. Second, because construction-related effects on water quality are temporary in nature, they tend not to be cumulative over time. Consequently, the temporary construction-related effects on water quality resulting from constructing the selected BDCP alternative, including its CMs, would not contribute considerably to any adverse cumulative Delta water quality condition, nor would construction-related effects make an otherwise non-adverse cumulative Delta water quality condition for any constituent/parameter adverse. Because construction-related activities are not expected to contribute considerably to any adverse cumulative Delta water quality condition, they also would not contribute considerably to any adverse cumulative water quality condition in water bodies located in the SWP/CVP Export Service Areas. No mitigation is required.

Cumulative Impact WQ-2. Cumulative impacts on water quality Upstream of the Delta resulting from facilities operations and maintenance (CM1) and implementation of conservation measures (CM2–CM22).

Alternatives 1A through 9

Constituent loading from upstream watersheds and resultant concentrations/levels in the water bodies upstream of the Delta would remain unchanged, or would be negligibly affected, by implementation of facilities operations and maintenance (CM1) under Alternatives 1A-9. Changes in seasonal reservoir storage levels and river flows from altered system-wide operations under Alternatives 1A-9 would have negligible, if any, effects on water quality in the rivers and reservoirs upstream of the Delta. Consequently, facilities operations and maintenance (CM1) under any of the Alternatives 1A-9 would not be expected to contribute considerably to any cumulative water quality condition within the affected environment, upstream of the Delta.

Regarding CM2-CM22, the measures or components of these measures that would be implemented in areas upstream of the Delta would be: 1) the Yolo Bypass Fishery Enhancement (CM2), 2) Conservation Hatcheries (CM18), and 3) Urban Stormwater Treatment (CM19). CM2 is a fish enhancement measure and, thus, is not expected to alter water quality upstream of the Delta. CM18 involves the operation of a new fish hatchery, discharges from which would be required to meet NPDES permit requirements to protect water quality and beneficial uses. CM19 may involve actions to improve stormwater quality coming from urban areas outside the Delta, but that drain to Delta waters, and would result in either no effect or beneficial effects on water quality upstream of the Delta. All other conservation measures would be implemented in the Delta region. Maintenance activities associated with the physical structures would not result in substantial, adverse effects on water quality. Consequently, the implementation of CM2-CM22 is not expected to contribute considerably to any cumulative water quality condition within the affected environment, upstream of the Delta.

CEQA Conclusion: Implementation of BDCP Alternatives 1A-9 facilities operations and maintenance (CM1), and their associated CM2-CM22, would have negligible, if any, water quality effects on water bodies of the affected environment located upstream of the Delta. Any negligible effects that may occur would not contribute considerably to any adverse cumulative water quality condition in water bodies upstream of the Delta, nor would Alternative 1A-9 effects make an otherwise non-adverse cumulative water quality condition for any constituent/parameter adverse. No mitigation is required.

Cumulative Impact WQ-3. Cumulative impacts on water quality in the Delta and SWP/CVP Export Service Areas resulting from facilities operations and maintenance (CM1) and implementation of conservation measures (CM2-CM22).

When the effects of implementing any one of the BDCP Alternatives 1A-9 on water quality are considered (including the new conveyance facilities, fish screens, gates and other physical structures and their operations and maintenance activities) together with the potential effects of projects listed in Table X-3 and Attachment A of Appendix X – Alternatives Development Report, the cumulative water quality condition in the Delta Region and SWP/CVP Export Service Areas for the following constituents is considered to not be adverse. Additional discussion for these water quality constituents is provided below.

- Ammonia

- Boron
- Dissolved oxygen
- Nitrate + Nitrite
- Pathogens
- Phosphorus
- Trace metals
- Turbidity/TSS

Ammonia

Ammonia levels are not expected to be adverse under the cumulative condition as a result of the Sacramento Regional Wastewater Treatment Plant, and other publicly owned treatment works (POTWs) that discharge to the Delta, nitrifying their effluent that is discharged to Delta tributaries and waters.

Boron

The lower San Joaquin River is listed on the State's Clean Water Act (CWA) section 303(d) list of impaired water bodies for salt and boron (SWRCB 2011). Boron is paired with salt in this listing due to its regular association with saline waters. The Central Valley Water Board has prepared a TMDL with an implementation program where it is expected that actions taken to control salts also will control boron as well (CVRWQCB 2006). With regulatory actions being taken to improve boron concentrations (and salinity in general on the San Joaquin River), the cumulative condition for boron is considered to not be adverse.

Dissolved Oxygen

Dissolved oxygen throughout the Delta is generally suitable for beneficial use protection, with the notable exception of the Stockton Deep Water Ship Channel. The TMDL for dissolved oxygen as well as CM14 (Stockton Deep Water Ship Channel DO improvement) of the BDCP is expected to further improve DO levels in the future. Thus, dissolved oxygen levels under the cumulative condition are not expected to be adverse.

Nitrate/Nitrite

Similar to ammonia levels, nitrate/nitrite levels in the Delta may be reduced in the future as Sacramento Regional Wastewater Treatment Plant and other POTWs discharging to Delta waters implement de-nitrification processes. The Central Valley Water Board is currently permitting such requirements with regularity and thus notable reductions in POTW-related nitrate/nitrite discharges are expected in the future, and other new or greater sources are not anticipated that would offset such point-source reductions. Thus, nitrate/nitrite levels under the cumulative condition are not expected to be adverse.

Pathogens

Similarly, increasingly stringent state regulations on both POTWs and urban runoff through the NPDES program is anticipated to reduce pathogen loading to Delta waters from these sources. As discussed in the project-specific analyses of alternatives, pathogen levels in the Delta are most affected by local factors, primarily local land uses and associated runoff from such lands. Conversion of Delta agricultural lands to tidal wetlands under the action alternatives may alter levels of coliforms and *E. coli* (either up or down), but would be expected to reduce loading of *Cryptosporidium*. Moreover, increased municipal wastewater discharges resulting from future population growth would not be expected to measurably increase pathogen concentrations in receiving waters due to State and Federal water quality regulations requiring disinfection of effluent discharges and the State's implementation of Title 22 filtration requirements for many wastewater dischargers in the Sacramento River and San Joaquin River watersheds. Municipal stormwater regulations and permits have become increasingly stringent in recent years, and such further regulation of urban stormwater runoff is expected to continue in the future. Implementation of BDCP CM 19 (Urban Stormwater Treatment) also may reduce pathogen loading to Delta waters. The ability of these BMPs to consistently reduce pathogen loadings and the extent of future implementation is uncertain, but would be expected to improve as new technologies are continually tested and implemented. Also, some of the urbanization may occur on lands used by other pathogens sources, such as grazing lands, resulting in a change in pathogen source, but not necessarily an increase (and possibly a decrease) in pathogen loading. In sum, Delta pathogen levels are not anticipated to be adverse under the cumulative condition.

Phosphorus

Primary sources of phosphorus to Delta waters include agriculture, municipal POTWs, individual septic treatment systems, urban runoff, stream bank erosion, and decaying plant material. Due to increased regulations and regulatory monitoring anticipated in the future, which will likely include water quality objectives for phosphorus, loading from agriculture, municipal POTWs, individual septic treatment systems, and urban runoff are all expected to remain at similar levels, or decline, under the cumulative condition. Loadings from stream bank erosion and decaying plant are not expected to change notably in the future. Hence, phosphorus levels are not anticipated to be adverse under the cumulative condition.

Trace Metals

Primary sources of trace metals to Delta waters include acid mine drainage (e.g., zinc, cadmium, copper, lead) from abandoned and inactive mines (i.e., Iron Mountain and Spring Creek mines) in the Shasta watershed area, which enter the Sacramento River system through Shasta Lake and Keswick Reservoir, agriculture (e.g., copper and zinc), POTW discharges (e.g., copper, zinc, and aluminum), and urban runoff (e.g., zinc, copper, lead, cadmium). Continued efforts to control acid mine drainage into the Sacramento River system and increasingly stringent regulations are expected in the future. Monitoring and regulatory controls on agricultural runoff, POTW discharges, and urban runoff are anticipated to prevent trace metal concentration under the cumulative condition from becoming adverse.

Turbidity/TSS

Future land use changes could have minor effects on TSS concentrations and turbidity levels throughout the affected environment. Site-specific and temporal exceptions may occur due to localized temporary construction activities, dredging activities, development, or other land use changes. These localized actions would generally require agency permits that would regulate and limit both their short-term and long-term effects on TSS concentrations and turbidity levels to less-than substantial levels. Construction activities are closely regulated under construction NPDES permits, which require the preparation of a SWPPP and the implementation of agency permitted construction BMPs that will minimize sedimentation into adjacent water bodies which would, in turn, increase turbidity/TSS. Moreover, construction projects are short-term in nature and thus their effects on turbidity/TSS tend not to be additive among multiple construction activities over time. Consequently, Delta turbidity/TSS levels under the cumulative condition are not expected to be adverse.

Because the cumulative water quality condition in the Delta for the constituents discussed above are considered to not be adverse in the Delta when considering all past, present, and reasonably foreseeable projects and regulatory actions, and because this cumulative condition includes the anticipated effects of implementing the facilities operations and maintenance (CM1) of any one of the BDCP Alternatives 1A-9, along with their associated CM2-CM22, none of these alternatives would contribute to an adverse cumulative condition for these constituents either in the Delta Region or the SWP/CVP Export Service Areas.

Cumulative water quality conditions for the constituents listed below are considered to be adverse, or have reasonable potential to be adverse, in portions of the Delta. Adverse cumulative water quality conditions for these constituents are expected when the effects of implementing any one of the BDCP Alternatives 1A-9 on water quality are considered (including the new conveyance facilities, fish screens, gates and other physical structures and their operations and maintenance activities) together with the effects of past, present, and reasonably foreseeable projects, including those listed in Table X-3 and Attachment A of Appendix X – Alternatives Development Report.

- Bromide
- Chloride
- Electrical Conductivity
- Mercury
- Organic Carbon
- Pesticides and Herbicides
- Selenium

Each of the constituents listed above, for which the cumulative Delta conditions are determined to be adverse, or potentially adverse, are discussed further below to determine whether implementation of the BDCP Alternatives 1A-9 would contribute considerably to these adverse cumulative water quality conditions.

Bromide

The cumulative condition for bromide is considered adverse in the Delta, because of marked increases in bromide concentrations anticipated to occur in the northwest Delta, including at the North Bay Aqueduct intake at Barker Slough, but not in the SWP/CVP Export Service Areas south of the Delta due to greater source fraction of Sacramento River water on an annual average basis at the south Delta pumps under all alternatives. Implementation of facilities operations and maintenance (CM1) under Alternatives 1A-9 would contribute considerably to this adverse cumulative condition for bromide. Implementation of CM2-CM22 would not contribute considerably to this adverse cumulative condition.

Chloride

The cumulative condition for chloride is considered adverse in the Delta, because of marked increases in chloride concentrations anticipated to occur in the western Delta, including Suisun Marsh, and the interior Delta, but not in the SWP/CVP Export Service Areas south of the Delta due to greater source fraction of Sacramento River water on an annual average basis at the south Delta pumps under all alternatives. Implementation of facilities operations and maintenance (CM1) under Alternatives 1A through 9 would contribute considerably to this adverse cumulative condition for chloride. Implementation of CM2–CM22 would not contribute considerably to this adverse cumulative condition.

Electrical Conductivity

The cumulative condition for EC is considered to be adverse, at various Delta locations and Suisun Marsh, depending on BDCP alternative implemented. EC levels at the south Delta export pumps would improve under all alternatives and thus the cumulative EC condition at the export pumps would not be adverse. As such, cumulative EC levels in the SWP/CVP Export Service Areas would not be adverse. The effects of Alternatives 1A–9 would contribute considerably to the adverse cumulative conditions for EC in the Delta and in Suisun Marsh. Implementation of CM2–CM22 would not contribute considerably to this adverse cumulative condition.

Mercury

Numerous regulatory efforts have been implemented or are under development to control and reduce mercury loading to the Delta, Upstream of the Delta and in the SWP/CVP Export Service Areas, which include a Delta mercury TMDL and its implementation strategies, increased restrictions on point-source discharges such as POTWs, greater restrictions on suction dredging in Delta tributary watersheds, and continued clean-up actions on mine drainage in the upper watersheds. A key challenge surrounds the pool of mercury deposited in the sediments of the Delta which cannot be readily or rapidly reduced, despite efforts to reduce future loads in Delta tributaries, and serves as a source for continued methylation and bioaccumulation of methylmercury by Delta biota. Consequently, mercury levels in Delta waters are considered to be an adverse cumulative condition. Facilities operations and maintenance (CM1) of Alternatives 1A-9 would not be expected to substantially alter the cumulative condition for mercury and the mercury impairment in the Delta or contribute considerably to the cumulative mercury condition in the SWP/CVP Export Service Areas. Implementation of CM4 (tidal wetland habitat), CM5 (floodplain habitat), and CM10 (freshwater marsh habitat) could create conditions resulting in increased methylation of mercury within the Delta per unit time, increased biotic exposure to and uptake of methylmercury, and resulting increased mercury bioaccumulation in fish tissues. The methylation of mercury in these restored wetland habitats would contribute considerably to the cumulative condition for mercury in the Delta.

Organic Carbon

Delta water quality conditions for dissolved organic carbon (DOC) are anticipated to be adverse under the cumulative condition. However, facilities operations and maintenance (CM1) for Alternatives 1A-5 would not contribute considerably to the adverse cumulative condition for DOC within Delta waters. Conversely, Alternatives 6A-7 and Alternative 9 would result in increased DOC levels at Franks Tract, Rock Slough and Contra Costa PP No. 1. Under these alternatives, long-term average DOC concentration could increase by up to 46%, relative to existing conditions. Thus, the

DOC contributions from alternatives 6A-7 and Alternative 9 at Franks Tract, Rock Slough and Contra Costa PP No. 1 (i.e., interior Delta locations) are determined to contribute considerably to the adverse cumulative condition for DOC in the Delta. However, overall, modeling results for the south Delta pumps and thus the SWP/CVP export service area predict a long-term improvement in export service area water quality, primarily through a reduction in exports of water exceeding 4 mg/L. This is particularly true for Alternatives 6A-C, 7 and 9 where notable improvements to DOC levels at the south Delta pumps would occur. Hence, facilities operations and maintenance (CM1) for Alternatives 6A-C, 7 and 9 would contribute considerably to adverse cumulative conditions in the interior Delta, but would improve cumulative DOC conditions at the south Delta pumps and thus in the SWP/CVP Export Service Areas.

In addition, implementation of CM4 (tidal wetland habitat), CM5 (floodplain habitat), and CM10 (freshwater marsh habitat) would create substantial new localized sources of DOC to Delta waters, and in some circumstances would substitute for existing sources related to replaced agriculture. Depending on localized hydrodynamics and proximity to municipal drinking water intakes, such restoration activities could contribute substantial amounts of DOC to municipal raw water supplies. The potential for substantial increases in long-term average DOC concentrations related to the habitat restoration elements of CM4, CM5, and CM10 could contribute to long-term water quality degradation with respect to DOC and, thus, adversely affect the MUN beneficial use at various locations within the Delta. Hence, Implementation of CM2-CM22 would contribute considerably to the adverse cumulative condition for DOC.

Pesticides and Herbicides

Pesticide and herbicide use within and upstream of the Delta are changing continuously. Historically, when society has substituted one class of pesticide for another without a corresponding change in patterns of use (i.e., substitution of organochlorines with organophosphates), incidence of non-target toxicity or environmental harm has changed and perhaps been lessened, but has remained nevertheless. While factors such as TMDLs and future development of more target specific and less toxic pesticides will ultimately influence the future cumulative condition for pesticides, forecasting whether these various efforts will ultimately be successful at resolving current pesticide related impairments requires considerable speculation. As such it is conservatively assumed that the cumulative condition will be adverse with respect to pesticides. Alternatives 1A-5 are not expected to contribute considerably to the adverse cumulative condition due to facilities operations and maintenance (CM1). Implementation of CM1 under Alternatives 6A-C, 7, and 9 would result in long-term average San Joaquin River source water fractions at Buckley Cove, Franks Tract, Rock Slough and Contra Costa PP No. 1 (interior Delta) increasing considerably for some months such that the long-term risk of pesticide-related toxicity to aquatic life could substantially increase at these locations. Additionally, the potential for increased incidence of pesticide related toxicity could include pesticides such as chlorpyrifos and diazinon for which existing Clean Water Act section 303(d) listings exist for the Delta, and thus existing beneficial use impairment could be made discernibly worse. In addition, implementation of CM13 (nonnative aquatic vegetation control) under Alternatives 1A-9 would be expected to contribute considerably to the adverse cumulative condition for pesticides and herbicides in the Delta. The greater source fraction of Sacramento River water on an annual average basis at the south Delta pumps under all alternatives would be expected to result in the cumulative condition for pesticides and herbicides in the SWP/CVP Export Service Areas to not be adverse.

Selenium

The lower San Joaquin River is listed as impaired in accordance with section 303(d) of the Clean Water Act for exceeding selenium water quality objectives. The impairment is listed as extending from the Salt Slough confluence to the Airport Way Bridge near Vernalis, a reach distance of approximately 50 river miles. Selenium occurs naturally throughout the lower San Joaquin River watershed, with elevated concentrations of selenium occurring in the shallow groundwater within the Grassland Watershed. Subsurface agricultural drainage discharges from this area are the major source of selenium to the San Joaquin River and Delta. Load allocations for agricultural subsurface drainage discharges from the Grassland Drainage Area have been developed through completion of the lower San Joaquin River selenium TMDL and the Grassland Bypass Project. The Grassland Bypass Project prevents discharge of subsurface agricultural drainage water into wildlife refuges and wetlands. The Grassland Area Farmers have been successful in meeting TMDL wasteload allocations and continue to utilize and expand the San Joaquin River Water Quality Improvement Project. Moreover, the Grassland Area Farmers continue to work closely with the Central Valley Water Board and U.S. Bureau of Reclamation to further develop and improve their drainage solutions for the Grassland Drainage Area. Despite these improvements in reducing selenium loading to the San Joaquin River and Delta, it is anticipated that the cumulative condition for selenium in the lower San Joaquin River and Delta will remain adverse. Facilities operations and maintenance (CM1) of Alternatives 1A-9 would not be expected to substantially alter the cumulative condition for selenium and selenium impairment in the Delta. Also, the greater source fraction of Sacramento River water on an annual average basis at the south Delta pumps under all alternatives would be expected to result in a cumulative condition for selenium in the SWP/CVP Export Service Areas that would not be adverse. Implementation of CM4 (tidal wetland habitat), CM5 (floodplain habitat), and CM10 (freshwater marsh habitat) could create conditions resulting in increased flow residence time at the restored Delta locations, which could increase biotic exposure to and uptake of selenium, potentially resulting in increased selenium bioaccumulation in fish tissues. The potential for increased biotic exposure in and near these restored wetland habitats would contribute considerably to the adverse cumulative condition for selenium in the Delta.

***CEQA Conclusion*:** The cumulative Delta water quality conditions are anticipated to be adverse for bromide, chloride, electrical conductivity, mercury, organic carbon, pesticides and herbicides, and selenium. Alternatives 1A-9 would contribute considerably to adverse bromide, chloride, and electrical conductivity conditions at various Delta locations, but would not contribute considerably, and would, in fact, improve conditions for these constituents at the Banks and Jones pumping plants in the south Delta and thus in the SWP/CVP Export Service Areas. Regarding mercury and selenium, facilities operations and maintenance (CM1) would not be expected to contribute considerably to the adverse cumulative mercury and selenium conditions in the Delta, but implementation of CM4, CM5, and CM10 would be expected to contribute considerably to certain localized areas within the Delta through the potential for increased mercury methylation and selenium bioaccumulation in these restored wetland habitats. The cumulative conditions for mercury and selenium are considered to not be adverse in the SWP/CVP Export Service Areas. For organic carbon, implementation of facilities operations and maintenance (CM1) for Alternatives 6A-C, 7, and 9 would contribute considerably to the adverse cumulative organic carbon condition in the Delta, as would implementation of CM4, CM5, and CM10 through the ability of these new wetlands to load additional organic carbon to Delta waters. These cumulative effects are not expected to extend to the south Delta pumps or the SWP/CVP Export Service Areas, but to the extent that they do, the mitigation measure proposed also would address such effects. Likewise, implementation of facilities operations and maintenance (CM1) for Alternatives 6A-C, 7, and 9 would contribute considerably to the adverse cumulative pesticide and herbicide condition in the Delta, as would implementation of CM13 (nonnative aquatic vegetation control). The cumulative effects for pesticides and herbicides are not expected to extend to the SWP/CVP Export Service Areas due to the increases in Sacramento River source fraction at Banks and Jones pumping plants under all alternatives and its generally lower levels of pesticides relative to the San Joaquin River source water.

Mitigation Measures:

The following mitigations measures have been developed to mitigate the alternatives' contributions to the adverse cumulative water quality conditions described above for bromide (WQ-5), chloride (WQ-7), electrical conductivity (WQ-11), mercury (see mitigation measure below), organic carbon (WQ-17 and WQ-18), pesticides and herbicides (WQ-21 and WQ-22) and selenium (see mitigation measure below).

To mitigate the alternatives' contribution to adverse mercury effects, implementation of conservation measures (CM4, CM5, and CM10) associated with wetland habitat shall conform to the relevant requirements of the Delta Mercury Control Strategy of the Central Valley Water Board Basin Plan. Requirements of the Delta Mercury Control Strategy include the following.

- Required participation in efforts to evaluate and minimize health risk associated with eating mercury contaminated fish.
- Required participation in monitoring methyl mercury loading from wetlands.
- Implementation of appropriate and site-specific methyl mercury control measures.

It is anticipated that these same, or similar, measures can be utilized to address and mitigate wetland-related bioaccumulation issues for selenium, as well.

Appropriate mercury, methyl mercury, and selenium control measures shall be developed at the time of formal restoration planning and design. All feasible measures to reduce methyl mercury and organo-selenium formation shall be implemented. Appropriate strategies and control measures may include the following.

- Conservation measure design features, such as use of seasonal inundation periods, hydraulic residence time, sediment basins and vegetation traps to control mercury ad selenium inputs and exports, inundation depths and related vegetation type and density selection so as to control oxidation-reduction conditions.
- Appropriate consideration of conservation measure location, preferably not in the direct path of large mercury or selenium loading sources such as the Sacramento River, Yolo Bypass, Cosumnes River, or San Joaquin River.
- Prioritization of conservation measures that minimize trophic level transfer of mercury and selenium through active or passive operation and maintenance controls, such as targeted control and/or removal of hyperaccumulating plant or animal species.
- Pre- and post-restoration monitoring of water and biota (sentinel species) for mercury and selenium content in the context of a targeted adaptive management strategy whereby new or modified mercury/methyl mercury and selenium controls would be implemented in order to, at the minimum, maintain methyl mercury and organo-selenium formation and fish tissue accumulation at baseline conditions.

These mitigation measures may not completely eliminate the contributions identified to the adverse cumulative water quality conditions, but would be expected to lessen the contributions. Hence, some level of contribution to adverse cumulative conditions may remain after mitigation.

8.4 References

8.4.1 Printed References